AN INVESTIGATION INTO THE EFFECT OF TEXT-TO-SPEECH TECHNOLOGY FOR TWO PEOPLE WITH ACQUIRED DYSLEXIA

FIONA ADAMS

Supervisor: Dr. Carolyn Bruce

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Department of Human Communication Science
University College London

ProQuest LLC
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106-1346

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ABSTRACT

People with aphasia may experience difficulties reading and understanding written material. Text-to-speech (TTS) software has the potential to provide assistance to people with aphasia with poor reading skills. It converts text displayed on a computer screen into synthesised speech, so that the user can both see text on the screen and listen to it. Research has suggested TTS can provide substantial benefit to people with learning difficulties, allowing them to 'read' faster and improve their comprehension. There has been limited research into how this technology can help compensate for acquired reading difficulties.

This study investigated the effects of TTS on the reading skills of two people with acquired dyslexia, looking at any changes in reading rate, comprehension and levels of confidence. It also aimed to examine whether any effects of TTS were due to the simultaneous auditory and visual presentation of information or to auditory information alone. Participants' ability to read with and without TTS was compared across a number of tasks.

Whilst results showed no significant difference in comprehension between TTS and unaided reading, one participant experienced considerable improvements in reading rate. Confidence ratings were not significantly different. However, reports from one of the participants suggested that outside the constraints of experimental conditions TTS provides substantial assistance for his reading. Results also suggested both participants may be relying largely on only one of the TTS modalities. It was also proposed that the nature and demands of the different tasks affected the results considerably.

The results of this study add to our understanding of the potential benefits of TTS for people with aphasia. Further research is needed with larger numbers of participants to establish the extent of these benefits, as well as how much the precise nature of a person's reading impairment and concomitant difficulties determine the likelihood of any benefits.

1: INTRODUCTION

This investigation is concerned with the effect of text-to-speech (TTS) technology as compensation for two people with acquired reading difficulties. The purpose of the literature review is to consider briefly the process of reading comprehension and the use of the auditory route to compensate for reading difficulties, followed by a review of current opinion regarding the benefits of TTS technology for readers with literacy difficulties.

Reading difficulties commonly occur in aphasia (Benson & Ardila, 1996) and breakdown can occur at one or more levels. Both participants in this study, TA and WS, have an acquired dyslexia associated with aphasia.

1.1: The process of reading comprehension

Reading is a skill many adults perform without difficulty. Various models exist which explain the process of reading comprehension. Reading for meaning involves interactions between the text and the abilities of the reader, as well as individual interpretations of the text (Schwartz, 1984). It requires numerous skills which go beyond decoding and reading words accurately, including syntactic parsing of sentences, understanding the meaning of words and sentences and incorporating the meaning of the text with existing knowledge about the topic.

Working memory is 'the system or systems involved in the temporary storage of information in the performance of such cognitive skills as reading, learning and comprehension' (Baddeley, 1996) and is considered as having limited capacity. The precise role of working memory in comprehension is still debated, but more recently the view has come to be held that working memory is very important for the reading process; it is the system responsible for retaining information and concurrently processing it (Baddeley & Hitch, 1974). Studies have shown those with a low working memory span are more likely to experience difficulties

comprehending longer and more syntactically complex texts (Friedrich, Martin & Kemper, 1985).

Reading comprehension can also be affected by speed of processing and word recognition skills, as a result of 'limitations' in short-term memory (McBride-Chang, 2004). A person who has poor word decoding skills will have less space in their short-term memory to dedicate to understanding the meaning of a text.

1.2: Cognitive neuropsychological model for single word processing

The importance of word decoding to the skill of reading has led to a considerable amount of research investigating reading at the single word level. In their language-processing model for single words, Whitworth, Webster & Howard (2005) proposed that three stages are involved in reading words for meaning: visual orthographic analysis, the orthographic input lexicon and the semantic system. Whitworth et al's model (2005) makes clear the links between listening and reading. For example, if it is hypothesised an individual has an impairment affecting input to semantics from the orthographic lexicon and therefore has difficulty accessing the semantic system directly through reading, an alternative 'auditory' route could be utilised to compensate for this impairment. This involves accessing semantics from the phonological input lexicon. TTS systems work in this way; they provide the user with an alternative way of accessing written text.

1.3: TTS systems

'Assistive technology' is any technology with the potential to enhance the performance of persons with disabilities (Lewis, 1998). It offers ways to surmount barriers to full participation imposed by disabilities.

TTS systems, sometimes called speech synthesis systems, assistive reading software or reading machines, are one type of technology which provides assistance to many people with literacy difficulties.

Since the 1980s commercial software packages which convert printed material into speech have been available. These have now become widely available. This software scans printed documents, recognises the characters on the page using Optical Character Recognition (OCR), speaks the text to the user through a loudspeaker using a speech synthesiser and simultaneously displays the printed page on the computer monitor. As the computer speaks a word, it is highlighted on the screen, thereby providing a synchronised auditory and visual presentation of the text. This is also referred to as a bi-modal presentation (Lewis, 1998). In the case of some software, the phrase, sentence, or paragraph containing the spoken word is also highlighted, in a different colour, to draw attention to the context in which it is used.

The field of assistive reading software is a dynamic one and new software is constantly being developed. The majority of systems available today allow the user to control the speed at which the text is spoken, as well as the type of voice and font size. The user can decide to have the reading pause after each phrase, sentence or paragraph. The more sophisticated software is able to work with more complex material, including Web pages and PDF documents. The character recognition is more accurate and speech produced by the synthesiser is of a better quality and more 'human-sounding', with improved 'naturalness' and 'intelligibility'. This technology includes electronic dictionaries and study skill tools that facilitate active reading strategies, for example highlighting main ideas and supporting details, as well as building glossaries of important terms. Some of the products currently available with all the capabilities described are the Kurzweil 3000TM (Kurzweil Educational Systems) and WYNNTM (Freedom Scientific). Other less sophisticated products include WordSmithTM (TextHelp) and e-ReaderTM (CAST).

The software used in this study was ReadPlease 2003 (www.readplease.com), downloadable from the internet. This is a less sophisticated system than Kurzweil 3000TM but is much less costly.

1.4: Bi-modal presentation

Various studies have found a facilitative effect of a bi-modal presentation (in auditory and visual modes simultaneously) of different stimuli, including letters and words, for subjects without reading difficulties; (Miller, 1982; Lewandowski, Hursh & Kobus, 1985; Lewandowski & Kobus, 1993, cited in Montali & Lewandowski, 1996). This has been referred to as the redundant signals effect (RSE) (Kinchla, 1974). Research has shown when information is presented through visual and auditory channels simultaneously, speed of processing and memory recall are enhanced. For example, some studies have shown short-term memory is improved when a word or digit string is presented bi-modally (Frick, 1984; Roberts & Lewandowski, 1994; Lewandowski & Kobus, 1993, cited in Montali & Lewandowski, 1996). Hursh and Lewandowski (1985) found in their study with adults with dyslexia that participants were able to perform as well on tasks of word recall in the bi-modal condition as control subjects who had received only visual information.

Montali and Lewandowski (1996) proposed that the two sensory channels act as backups for each other, facilitating links between letters and sounds. They suggested poor readers who have difficulty decoding words are helped by the bi-modal presentation, which, in removing the need for so much decoding, frees up cognitive resources for higher level comprehension processes. Elkind, Cohen and Murray (1993) claimed the strength of one modality compensates for the weakness of another; aural abilities are often stronger than visual abilities in people with dyslexia.

1.5: Research into TTS as a means to remediate and compensate for literacy difficulties.

There has been much research into the remediation and compensation of acquired reading difficulties in the aphasic population (for example, Webb & Love, 1994; Nickels, 1995; Yampolsky & Waters, 2002; Friedman & Nitzberg Lott, 2002). However, most of this work has focused at the single word level and not at the

level of reading text. Research has so far not focused on the use of TTS software to help compensate for reading difficulties.

Much of the research into the benefits of text-to-speech systems has focused on children with learning difficulties (LD), especially developmental dyslexia. Recently there have been studies showing the benefits gained by adults with poor reading skills.

Some studies have addressed the use of TTS to help develop reading skills as opposed to compensating for reading difficulties. Wise and Olson (1992, 1995) demonstrated the effectiveness of computer speech synthesis in the instruction of basic phonic skills for children. In a study involving children with reading disabilities, Olson, Foltz & Wise (1986) found that speech feedback significantly benefited readers' comprehension and word recognition.

Other studies have investigated the use of TTS as a compensatory tool. The results are mixed. Farmer, Klein and Bryson's study with secondary school students with LD (1992, cited in MacArthur, Ferreti, Okolo & Cavalier, 2001) involved students reading a series of short stories with and without whole-word speech feedback for words chosen by the students. No differences were found on comprehension between the two conditions. In a study by Leong (1992), which in contrast to the Farmer et al. study (1992) used simultaneous auditory and visual presentation of complete passages, no effects were found for comprehension using TTS for above-or below-average readers. However, as noted by MacArthur at el. (2001), this may have been as a result of the readers in this study being 'below average' rather than poor readers or students with LD.

Despite the above findings, various studies have concluded TTS can be a valuable reading aid for many people with dyslexia. Montali and Lewandowski (1996) investigated the effects of TTS with 36 average readers and students with LD. Their study investigated performance on tasks of word recognition and passage comprehension in three conditions; visual, auditory and bimodal (TTS). Results showed comprehension scores of students with LD were significantly better in the bimodal condition as compared to the visual and auditory conditions. They also

found these students felt more successful in this condition and suggested TTS may therefore increase students' motivation.

In their study with 28 middle school students with dyslexia, Elkind et al. (1993) reported that 70% of students made gains in reading comprehension when using a computer reader. In this investigation and a subsequent one by Elkind, Black and Murray (1996), the BookWise computer reading system from Xerox (1993) was used and text was highlighted sentence by sentence. Students with high unaided comprehension scores benefited about as much as those with low scores. Not all students benefited; some saw no improvement and others saw their scores worsen. The two students whose scores worsened reported difficulty attending to information received via the auditory and visual modalities simultaneously. Several of the students disliked the synthesised speech. The three students who made the greatest improvements in terms of their scores had auditory strength and visual weakness. Some students reported gains in reading speed, increased attention span and endurance for reading; these aspects were not measured. The researchers added that TTS enabled many students to read with pleasure for longer.

Elkind et al's 1996 paper was the first to investigate the use of TTS as a compensatory tool for adults with dyslexia; all were diagnosed as LD, including three who had an acquired brain injury. Their conclusion from four studies was that TTS could provide 'substantial assistance' to many adults with dyslexia but that it was not beneficial to all.

In the first study, Elkind et al. (1996) found a significant increase in the mean reading rate of 25 wpm in the TTS condition compared with the unaided reading condition. Interestingly, this reading rate was still lower than that of their peer groups. Comprehension was assessed both after 20 minutes reading (timed) and after participants had completed the text (un-timed) for both unaided reading and aided reading (using TTS).

Whilst the mean result showed no significant difference between aided and unaided comprehension, the study found participants with very slow unaided reading or low unaided comprehension benefited most from TTS. In contrast, those with good unaided reading rate or comprehension were likely to experience a deterioration in performance, due to interference from TTS. In the second part of their study, Elkind et al. (1996) concluded that the extent of improvement in the aided condition could be predicted from students' timed unaided scores and scores in tests of auditory comprehension and recall; low scores in the unaided condition and higher than average scores in the other tests. The importance of having stronger auditory comprehension skills than visual skills to benefit from TTS was also highlighted, as it was in Elkind et al. (1993).

Elkind's study (1998) with post-secondary students with LD, in which the more sophisticated Kurzweil 3000 (1997) software was used, also found those with very slow unaided reading or low unaided comprehension scores benefited most from TTS. Similar results were noted by Higgins and Raskind (1997). Elkind (1998) found similar improvements in reading rate with TTS, however he noted that TTS comprehension scores were not significantly different to scores for unaided reading.

Fourteen of the original participants in Elkind's study (1996) used TTS for a period of 3 months to a year. Participants reported perception of improvement in comprehension (64%) and reading rate (86%) when using TTS, even when there had been no actual improvement. 93% found reading less stressful and tiring and 91% said they were able to sustain reading for longer. This was a particularly important result given that prior to the study, 75% of the participants had reported only being able to read for half an hour or less. In the 1998 study, 73% said reading was less tiring and stressful and the same number thought it would help with their reading. 85% stated they would like to use TTS.

Elkind et al. (1996) also investigated the use of TTS to supplement remediation of adult reading difficulties. Eight students with dyslexia used TTS technology for up to a year or more, in addition to their reading texts from the tutorials, as well as using it at home. The researchers reported various benefits, including developing

eye tracking ability and using the technology only when having difficulties with decoding certain words. Elkind et al. (1996) concluded TTS enabled students to progress more rapidly, due to access, practice and reinforcement, which enabled participants to read age appropriate material much earlier, read more independently and read a wider variety of materials. Students who decided not to participate in the study cited the following reasons: unintelligible voice quality of TTS, too much sensory input, absence of perceived improvement in reading performance, not enough time and not 'normal' enough. Some felt it was 'cheating' to use the software.

Elkind et al. (1998) carried out an additional study with eight people with dyslexia who used TTS in the workplace or at home. Positive results were reported for half of the participants, such as returning to work, change of job, improved unaided reading rate and comprehension and greater self-confidence. However, four of the participants reported negative results, citing the amount of time required to format text and small gains in reading rate, comprehension and endurance.

Higgins and Zvi's research (1995) investigated the effect of TTS on reading comprehension and proof reading skills of adults. They found no significant difference in comprehension test scores between unaided reading, reading with TTS and an auditory only condition in which a person read the text aloud. They reported that the poorest readers benefited most, with above average students showing an interference effect, although their results were not statistically significant. In the proofreading exercise, participants detected significantly more errors using TTS than in the unaided condition. This improvement was reflected in Raskind and Higgins' study (1995) with post-secondary students with LD. The researchers proposed this was because the simultaneous, multi-sensory feedback improved the students' ability to process and attend to errors. Although Raskind and Higgins (1995) did not look specifically at reading comprehension, a proof reading exercise requires the participant to be able to read the words in order to spot the errors and make corrections.

Another study investigated the effects of TTS on twenty secondary students with attention disorder (Hecker, Burns, Elkind & Katz, 2002). The researchers found TTS allowed students to attend better to their reading, concentrate for longer and that it reduced their distractibility, increased their reading rate and enabled them to read for longer. Students with attention disorder experience a variety of difficulties which can have a detrimental effect on their reading. Consistent with the results of Elkind et al. (1996), Elkind (1998) and Higgins and Zvi (1995), they found no significant effect on comprehension but noted that it did help some students with very poor comprehension, whilst making it more likely those with better comprehension experience some deterioration.

It appears from the research that TTS can be of benefit in a number of ways and to different degrees, depending on the nature of the difficulties and the skills of the individual. However, it is not a suitable aid for all those with reading difficulties.

1.6: Use of TTS with acquired literacy difficulties

There is little documented research concerning the use of TTS in aphasia. One such study was carried out by King and Hux (1995). The aim of the intervention programme, which lasted 8 weeks, was to find out whether using TTS would enable Mr C, who had mild aphasia, to reduce his spelling and language errors in writing. He was trained in the TTS system before the study was carried out. After intervention focusing on editing his own work using TTS, results showed the use of TTS led to a significant reduction in the number of errors. King and Hux (1995) suggested the spoken feedback enabled the participant to spot errors he missed with visual editing. However, the researchers did note the spoken computer feedback may not have been the only contributing reason for Mr C's improved editing and that the results should be interpreted with caution.

Two unpublished studies provide further evidence TTS technology may be beneficial for adults with acquired literacy difficulties. Trotman's study (2004) investigated the efficacy of a reading comprehension programme supplemented by the use of TTS technology in a woman with acquired dyslexia. Results showed a small decrease in RM's comprehension during the TTS condition,

although the amount of data was limited. Informal observations during the therapy sessions, however, indicated that by removing the difficulties she had in decoding unfamiliar words, TTS did aid her comprehension. A decrease in the time RM spent reading a text post-therapy suggested she may have improved her eye-tracking abilities as a result of using TTS.

Smith (2003) investigated the effects of TTS to compensate for reading difficulties in MH, a 32-year-old male with acquired dyslexia. While not all tests were statistically significant, Smith found during lengthier and more complex tasks his performance was significantly better in the TTS and hearing only conditions than when reading unaided. Reading time was significantly faster in the TTS conditions and confidence ratings showed the participant was more confident using TTS than when just hearing or reading written texts.

1.7: The investigation

The present investigation was based on Smith's 2003 study and aimed to examine the effects of TTS on the reading comprehension, reading rate and levels of confidence on two participants with acquired dyslexia. It also attempted to explore the question of whether any positive effects of TTS were due to its combined written and auditory input or auditory input alone. There is the possibility users of TTS are relying either heavily or almost exclusively on the auditory input to comprehend the texts they are reading.

2: METHOD

2.1: Subjects & background assessment.

Two people with aphasia who were attending a community speech and language therapy clinic participated in this study.

TA

TA was a 44 year old man who suffered a left hemisphere CVA in April 2004. He had been attending a community clinic for acquired communication disorders since November 2004 for twice weekly therapy.

He was born in Nigeria and started to learn English when he emigrated to England as a young child. Prior to his stroke he worked full time as an IT support engineer.

TA was keen to return to some form of paid employment and enrolled on a training course at a centre which aims to rebuild basic work-related skills.

At the time of this study, TA presented with moderate expressive dysphasia with specific word-finding difficulties, moderate to severe dyslexia and dysgraphia and a suggested mild to moderate cognitive impairment. Assessment on the Western Aphasia Battery (WAB; Kertesz, 1982) resulted in an aphasia quotient of 77 (see Table 2.4 below). He was classified as having an anomic type aphasia.

TA's scores from pre-assessment testing are given below.

Table 2.1: Scores from the Psycholinguistic Assessments of Language Processing in Aphasia (PALPA) - **TA**

PALPA	Score
Date: January 2006	
No.19 – Matching small and capital letters	13/13
No.24 – Legality Decision Task	15/15
No.49 –Auditory Synonym Judgements	High Imageability: 29/30
	Low Imageability:24/30
No.50-Reading: Written Synonym Judgements	High Imageability:24/30 Low Imageability:10/30
No.35-Spelling-Sound Regularity. (Reading single words aloud)	Regular Words:22/30 Exception Words:22/30
No.31-Imageability and Frequency, Reading Single Words Aloud	HI HF:19/20 HI LF:18/20 LI HF: 14/20 LI LF: 15/20 (HI: 37 / 40; LI: 29/40)
No.25-Imageability and Frequency.Visual Lexical Decision Task	Real words: 54/60 Non-words: 58/60 HI HF: 15/15 HI LF: 13/15 LI HF: 15/15 LI LF: 13/15
No.36-Non-word reading	7/24
No.53-Picture Naming (Reading Aloud Picture Names) -Spoken Picture Naming -Repeating Picture Names	37/40 32/40 40/40

Table 2.2: Scores from the John Hopkins University Dyslexia and Dysgraphia Batteries – **TA**

John Hopkins University Dyslexia and Dysgraphia Batteries	Score
Date: January 2006	
Reading Aloud: Nouns: Adjectives: Verbs: Function Words:	 22/28 19/28 18/28 8/8
Reading Aloud: Word Length: *4-letter words:* *5-letter words:* *6-letter words:* *7-letter words:*	 31/34 7/7 6/7 5/6 13/14

Table 2.3: Scores from the Reading Comprehension Battery for Aphasia – **TA**

Reading Comprehension Battery for Aphasia (RCBA-2)		
	Date: January 2006	Time taken to complete
Subtest	Score:	
I Word visual	9/10	30 mins
II Word auditory	8 /10	25 mins
III Word semantic	8 /10	28 mins
IV Functional reading	9 / 10	30 mins
V Synonyms	9 / 10	20 mins
VI Sentence-picture	8/10	32 mins
VII Paragraph-picture	6 / 10	45 mins
VIII Paragraph – factual	8 / 10	2 hrs 30 mins (along with paragraph-inferential)
IX Paragraph-inferential	8 / 10	2 hrs 30 mins (along with paragraph-factual)
X Morpho-syntax	9 / 10	35 mins
Total Score	**82 / 100**	

Table 2.4: Scores from the Western Aphasia Battery (WAB) – **TA**

Western Aphasia Battery	
	Date: February 2006
Subtest:	Score:
Spontaneous Speech	Total:14/20 (Information Content:9 Fluency: 5)
Auditory Verbal Comprehension	A. Yes/No Questions:54/60 B.Auditory Word Recognition: 56/60 C.Sequential Commands:80/80
Repetition	98/100
Naming	A.Object Naming:37/50 B.Word Fluency:1/20 C.Sentence Completion:8/10 D.Responsive Speech:6/10
Aphasia Quotient	77

Table 2.5: Scores from the Working Memory Test Battery for Children – **TA**

Working Memory Battery	**Score**	
	Date: February 2006	
Digit Recall:	Trials Correct: 38	Span: 7
Listening Recall:	Trials Correct:13	Span:1
Backward Digit Recall:	Trials Correct:9	Span:2

Reading

Testing using the Psycholinguistic Assessments of Language Processing in Aphasia (PALPA; Kay, Lesser & Coltheart, 1992; see Table 2.1) showed he was able to distinguish between real and non-words (PALPA subtest 24, 15/15). Tests requiring auditory synonym judgements (PALPA subtest 49, high imageability: 29/30; low imageability: 24/30) and written synonym judgements (PALPA subtest 50, high imageability: 24/30; low imageability: 10/30) revealed a more significant impairment of the semantic system in the written modality, with greater imageability effects.

TA's performance in the Comprehensive Aphasia Test (Swinburn, Howard & Porter, 2005) revealed his comprehension of spoken language (36/66) was better than that of written language (14/62). His comprehension of written words (14/30) was markedly better than his comprehension of written sentences (0/32).

TA's performance in reading aloud tasks was considerably worse than his silent reading. His reading aloud of single words is extremely slow. PALPA results revealed there was a more of an imageability effect than a frequency effect. (PALPA subtest 31, high imageability, 37/40; low imageability, 29/40; high frequency, 33/40; low frequency, 33/40). There was no evidence of any regularity effects. Semantic and visual errors were made when reading aloud. For example he said 'pat' for 'pact', 'traitor' for 'tractor' and 'heavy' for 'gravy'.

The above assessments suggested that when reading aloud, TA was using a grapheme-phoneme strategy, which was impaired; he attempted to spell out words

letter by letter. He sometimes had difficulty identifying individual letters within a word (for example 'k' in 'take') and was then unable to identify how it would sound.

The reason for TA's difficulties with reading aloud were not clear. He appeared to have difficulty accessing the phonological output lexicon from the orthographic input lexicon (Whitworth et al., 2005). However, his phonology seemed relatively intact, with a strong performance on repetition tasks and no phonological problems on naming tasks.

TA scored higher on reading aloud of picture names (PALPA Subtest 53, 37/40) than he did on spoken picture naming (Subtest 53, 32/40). In the latter task, when he was unable to provide the exact word, he was often able to give correct semantic information. For example, for 'seal' he said 'it lives in cold water sometimes'.

His score on the PALPA test of non-word reading (subtest 36, 7/24) indicated a severely impaired sub-lexical reading route. 'Cug' was read as 'kʌd', 'lat' as 'ləd', 'hance' as 'ʃʌn' and 'grest' as 'grʌʃt'.

TA scored 82/100 on the Reading Comprehension Battery for Aphasia (RCBA-2, La Pointe and Horner, 1998; see Table 2.3). His single word reading contained some errors. He had significant difficulties in comprehending text at the paragraph level. He scored higher on the Functional Reading and Synonyms sub-tests (9/10) than he did on the three paragraph tests (paragraph-picture: 6/10; paragraph-factual: 8/10; paragraph-inferential; 8/10). Observation revealed difficulties were often encountered when he was unable to decode two or three words within a sentence, making it difficult for him to understand the meaning. His silent reading was very slow; his scores on the RCBA must be considered in combination with the time he took to provide his answers; subtests VIII (paragraph-factual) and IX (paragraph inferential) took 2 hours 30 minutes to complete.

Both testing undertaken at the clinic and as background assessment for this study suggested TA's difficulties were characteristic of deep dyslexia (Coltheart, Patterson & Marshall, 1987). This involves reading via an impaired semantic lexical route. The sub-lexical route is also impaired (Whitworth et al, 2005). Characteristic features include the occurrence of semantic errors in single-word reading, an inability to read nonwords and high-imageability (concrete) words being better read than low-imageability (abstract) words.

Auditory Comprehension

His auditory comprehension was a relative strength; his score from the WAB was 9.5/10, including 80/80 for the sequential commands. He followed conversation well in a one to one setting but struggled in a group environment, not always understanding what was said and having to ask for repetitions.

Cognition and Working Memory

Testing on the Raven's matrices showed TA's non-verbal IQ was within average limits for the non-aphasic population. He scored 10/12; the normal performance mean is 10.3 and the aphasic performance mean is 7.3. His verbal digit span was seven numbers, which is normal for most adults (Working Memory Test Battery for Children, Pickering and Gathercole, 1981; see Table 2.5). In the repetition subtest of the WAB he scored 98/100. However, observations in the clinic suggested he had additional cognitive difficulties, including impaired working memory and slow processing speed. TA also reported during clinic sessions that he needed to keep a diary to help him remember dates and times of appointments.

Spoken language

TA's spoken output was variable. When talking about a topic of interest he was moderately fluent and used complex sentences and high level vocabulary. In structured situations his speech was marked by hesitancies, fillers and marked word finding difficulties. He scored 14/20 in the Spontaneous Conversation

section of the WAB (information content: 9/10; fluency 5/10), showing evidence of paraphasias and word finding difficulties, for example in the picture description he was unable to name 'tree' and 'boat'. He scored 52/90 in the Naming section; word fluency (1/20) and object naming (37/50) presented particular difficulties.

Writing

TA had limited written output. He was able to copy words accurately, however his spelling to dictation was limited to simple and familiar words.

TA was selected as a participant in this study as he had been using ReadPlease TTS software at home for approximately two years and found it extremely useful. He reported ReadPlease enabled him to read longer and more complex texts.

WS

WS was a 44 year old woman who suffered a left hemisphere CVA in March 2003. Since September 2004, she had been attending twice weekly therapy at a community clinic for acquired communication disorders.

WS was not in employment at the time of her CVA but had worked approximately ten years previously as a Care Officer for the council. English was her first language. WS was keen to return to some form of paid employment and had just enrolled on a training course at a centre which aims to rebuild basic work-related skills.

At the time of this study, WS presented with mild expressive language difficulties, particularly word-finding, and mild receptive language difficulties, particularly with longer, more complex sentences. She also had acquired dyslexia and dysgraphia. WS scored a quotient of 86.3 on the WAB (Kertesz, 1982; see Table 2.7), reflecting a conduction aphasia.

WS's scores from pre-assessment testing are given below.

Table 2.6: Scores from the Reading Comprehension Battery for Aphasia – **WS**

Reading Comprehension Battery for Aphasia (RCBA-2)	
	Date: July 2006
Subtest	Score:
I Word visual	10 / 10
II Word auditory	10 / 10
III Word semantic	10 / 10
IV Functional reading	8 / 10
V Synonyms	10 / 10
VI Sentence-picture	10 / 10
VII Paragraph-picture	7 / 10
VIII Paragraph – factual	10 / 10
IX Paragraph-inferential	10 / 10
X Morpho-syntax	6 / 10
Total Score	**91/100**

Table 2.7: Scores from the Western Aphasia Battery (WAB) –**WS**

Western Aphasia Battery	
	Date: July 2006
Subtest:	Score:
Spontaneous Speech	Total:19/20 (Information Content:10 Fluency: 9)
Auditory Verbal Comprehension	A.Yes/No Questions 57/60 B.Auditory Word Recognition:60/60 C.Sequential Commands: 48/80
Repetition	64/100
Naming	A.Object Naming:57/60 B.Word Fluency:20/20 C.Sentence Completion:8/10 D.Responsive Speech:10/10
Aphasia Quotient	**86.3**

Table 2.8: Scores from the Working Memory Test Battery for Children -**WS**

Working Memory Battery	Score	
	Date: July 2006	
Digit Recall:	Trials Correct: 22	Span: 4
Listening Recall:	Trials Correct:10	Span:1
Backward Digit Recall:	Trials Correct:9	Span:2

Reading

Testing using the RCBA-2 (La Pointe and Horner, 1998; see Table 2.6) revealed no difficulties with single word reading (subtests I, II & III, 10/10), some difficulties at the paragraph level (subtest VII, paragraph picture, 7/10; subtest VIII, paragraph factual, 10/10; subtest IX, paragraph inferential,10/10) and specific problems understanding morphosyntactic complexity, (subtest X, morpho-syntax, 6/10) particularly embedded clauses. Observation in therapy sessions showed WS was able to read a page of simple text and extract factual information. She had particular problems reading more complex texts; she had difficulties making inferences and processing and retaining the information. It is possible the amount of processing required to recognise words interfered with her ability to read for meaning.

Auditory comprehension

Her auditory comprehension score on the WAB (Kertesz, 1982; see Table 2.7) was slightly lower than TA's (8.25), having scored only 48/80 for sequential commands. Her errors indicated difficulties with auditory retention span and possibly with comprehension of syntax, since she found it increasingly difficult as the commands increased in length and complexity. Results from the Test for Reception of Grammar (TROG-2, Bishop, 2003) revealed particular difficulties with passive and reversible sentences and embedded clauses. For example, she was unable to respond correctly to 'the girl is chased by the horse' and 'the pencil is on the book that is yellow'.

Observation revealed WS's understanding depended on the length and complexity of the sentences and the speed of delivery. She found it easier to follow short, simple sentences presented slowly, giving her more time to process the information. She reported particular problems understanding conversations when not in a one-to-one situation, where she was more reluctant to ask for repetitions.

WS reported finding it difficult to follow what she heard when unable to derive clues from facial expression; she did not like talking to people over the phone,

preferring to send text messages. WS processed information best when it was presented in both the spoken and the written form; she used television subtitles to aid her understanding of the spoken information.

Cognition and working memory

WS's scores on the Working Memory Test Battery for Children (Pickering and Gathercole, 1981; see Table 2.8) indicated some difficulties; her verbal digit span was 4. Her performance in the repetition section of the WAB was considerably poorer than TA's (64/100).

Spoken language

WS scored better than TA on the spontaneous speech and naming sections of the WAB (19/20 and 9.5/10 respectively). She had a slow speech delivery and word finding difficulties were frequent, but she was an effective communicator, using facial expression, gesture and writing to convey her message.

Writing

WS had functional writing skills; she was able to write in short sentences but had some difficulty with the grammatical aspects and finding the correct word.

WS was selected as a participant for this study as, in contrast to TA, she reported not having found ReadPlease useful. This was surprising as she had reported watching the television was helped by having subtitles, suggesting that bi-modal presentation might help her follow a spoken and possibly a written narrative. It was possible that familiarisation might make using ReadPlease more beneficial.

2.2: Materials

The TTS software programme used in this study, ReadPlease 2003, was installed on a Dell Optiplex SX280 computer. The texts used in the assessments were copied from pre-prepared Word documents and pasted into the ReadPlease text box.

All tasks were carried out in the following conditions: Reading Only (RO), Text-to-Speech (TTS) and Hearing Only (HO), with the exception of the Passport task, which had only RO and TTS conditions. Written text was presented on the computer and in TTS and HO conditions computer speech was used.

Reading comprehension and rate were measured using a variety of tasks. This was due to the fact that word-finding difficulties may make it difficult for participants to demonstrate their knowledge.

ASSESSMENT TASKS

Passage Comprehension Task (see Appendix I)

The aim of this task was to assess the participants' comprehension of fifteen passages of differing lengths and complexity, taken from New Reading Analysis (Vincent and de la Mare, 1985). There were five passages in each condition; passage 1 was the shortest and most straightforward, with passage 5 being the longest. The style of the passage varied from factual and historical information to instructional information, such as a cooking recipe, becoming longer and more linguistically and syntactically complex as the task progressed. This task tested the participants' ability to make inferences, as well as involving recall of factual information.

Passages were matched for length and complexity across all three conditions. Comprehension was measured by the tester asking participants a number of questions; these were presented orally and the participants answered orally.

Sentence Completion Task (see Appendix II)

This task was selected to assess the participants' comprehension of sentences. Sentences were taken from the Vernon-Warden Reading Test from the Kirklees Assessment (Hedderly, 1994). A total of twenty four sentences of increasing length and difficulty were presented in each condition. To keep the demands as similar as possible, it was decided to use only twenty four of the original forty two sentences, as these all had the missing word at the end of the sentence.

They were required to choose the correct word to complete a sentence, from a choice of five, highlighted in bold. For TTS and RO, participants gave their answer orally or by pointing to their selected word. For HO, they heard the five possible answers 'spoken' by the computer and gave their answer orally.

Map Marking Task (see Appendix III)

This task tested comprehension and recall of factual information. The three passages, matched for length and complexity, were approximately 25 words longer than the three longest passages in the Passage Comprehension task. The test questions were ordered so that the participants were required to recall details from the passage out of chronological order.

Comprehension was tested by a series of instructions which the tester asked the participants orally. They then marked points on the map. One passage and its accompanying map were taken from Reading to Some Purpose, Book 6 (Flowerdew and Rideout, 1965). This was used as a template for the two remaining passages and maps, written by Carolyn Bruce as part of Smith's BSc dissertation (2003); they were matched for length and complexity. Each of the three passages and corresponding maps were assigned to one of the three conditions.

Passport Task (see Appendix IV)

This task assessed the participants' ability to read a passage and manipulate the information in order to complete a form.

Two short passages containing information about two different people were used, devised by Carolyn Bruce. Each passage was assigned to one condition (RO or TTS) and they were matched for length and complexity. Following the presentation of each text, participants were required to complete a 'passport form' in writing.

QUALITATIVE MEASURES

Confidence Rating Scale (see Appendix V)

Following the comprehension questions, participants were asked to rate their confidence in relation to the accuracy of each answer given. This involved pointing to and / or saying out loud a number from the rating scale provided on a sheet of paper (see Appendix VIII). It was decided to use a Likert-scale (Likert, 1932) from 1-9 as this has been shown to be a more reliable measure

Questionnaire (see Appendix VI)

The questionnaire, devised by the tester, was presented on paper, with the tester also reading the headings out loud where necessary. Participants were asked to comment on their use of reading pre- and post-stroke. They were asked to assess the importance and difficulty of certain tasks.

Interview (see Appendix VII)

In an informal interview at the end of the investigation, they were asked for their views on the ReadPlease software. This included the use of rating scale of 1-5, from 'strongly agree' to 'strongly disagree' relating to statements about the effects of ReadPlease.

2.3: Procedure

The tasks were carried out over six sessions with TA, totalling approximately eleven hours, in May and July 2006. WS was seen over four sessions in July 2006, totalling approximately seven hours.

It was explained by the tester that the tasks were being carried out to assess the participants' comprehension under three conditions: RO, TTS and HO. They were told that both the accuracy and speed of their responses was important.

Both participants were asked to choose the running speed and volume of the computer 'speech', as well as select their preferred voice, which remained the same throughout. TA chose the male UK voice and speed setting '-9' (equivalent to approximately 100 words per minute). WS also chose the male UK voice, with a faster speed setting of '-3' (equivalent to approximately 134 words per minute). Both selected font size 14 for the written text. The HO condition was presented using the speech generated by ReadPlease, with the participants turning away from the screen so they were unable to see the text.

With the exception of the Passport task, participants were allowed as long as they required for the RO condition and were unable to refer back to the text subsequently. They heard one presentation of the text in the HO condition and in the TTS condition they were able to look at the text presented on the screen until the audio presentation was complete.

Passage Comprehension Task

The 5 passages in each condition were presented during 3 sessions with TA and 2 sessions with WS. All the Passage 1 texts were presented in each condition before presentation of all the Passage 2 texts in each condition, and so on. The order of the conditions was controlled for practice effects and was as follows:

Passage 1:	RO, TTS, HO
Passage 2:	TTS, HO, RO
Passage 3:	HO, RO, TTS
Passage 4:	RO, TTS, HO
Passage 5:	TTS, HO, RO

The time taken for the participants to complete their reading of the passages in the RO condition was recorded. Presentation time (the time it took for the computer speech) was recorded for the TTS and HO conditions. For the TTS and RO conditions, there was only ever one passage visible on the screen at any one time. Following the comprehension questions, participants were asked to rate their confidence in relation to the accuracy of each answer given.

Sentence Completion Task

This task was carried out over three sessions. The twenty four sentences were divided into three sets of eight, of increasing length and difficulty. Each set of sentences was assigned a different condition within each session. Presentation order of the sentences as well as the order of the words from which the answer was to be chosen was randomised to minimise practice effects.

The presentation was as follows:

Condition	**Session 1 – sentences presented**	**Session 2- sentences presented**	**Session3- sentences presented**
RO	1-8	9-16	17-24
TTS	17-24	1-8	9-16
HO	9-16	17-24	1-8

For the TTS and RO conditions, there was never more than one sentence visible on the screen at any one time. They were also asked to rate their level of confidence.

Map Marking

Participants were presented with a passage in each condition. At the end of each presentation, they were given a map and instructed to mark on it their responses to verbal instructions from the tester. They were also asked to rate their confidence levels.

Passport Task

In order to familiarise the participants with the nature of the passport forms, they were asked to complete a form with their own details immediately before this task.

Participants were given a passport form to complete, presented on a sheet of white paper in Times New Roman font size 14. For this task, participants were able to refer back to the text as often as they liked in both conditions, whilst completing the form. In TTS, they were able to use the software to listen again to particular words or sections. Participants were asked to give an overall confidence rating for their performance in each condition.

3: RESULTS

The results for TA and WS are detailed together and are reported under three main sections: reading comprehension, confidence ratings and time.

3.1: READING COMPREHENSION

Passage Comprehension Task

Passages across conditions were matched for length but within conditions they gradually increased in length. Therefore the total possible score for the passages varied.

Table 3.1: Passage Comprehension: comprehension scores – TA and WS

TA

	Condition		
Passage No.& Total Possible Score	**RO**	**TTS**	**HO**
1 (/ 3)	1	2	3
2 (/ 3)	0	1	1
3 (/ 3)	0	1	0
4 (/ 7)	5.5	3.5	3
5 (/ 7)	0.5	1.5	3
Total	**7 / 23 (30.4%)**	**9 / 23 (39.1%)**	**10 / 23 (43.5%)**

WS

	Condition		
Passage No.& Total Possible Score	**RO**	**TTS**	**HO**
1 (/ 3)	1	3	2
2 (/ 3)	3	3	1
3 (/ 3)	2	2	0
4 (/ 7)	6	1	3
5 (/ 7)	6	5	3
Total	**18 / 23 (78.3%)**	**14 / 23 (60.9%)**	**9 / 23 (39.1%)**

TA's total scores did not vary considerably across conditions and were all very low. A chi-square statistical analysis showed no significant difference between conditions (Chi-square = 0.894, df = 2, p=0.65).

TA's scores in the RO conditions were very low for all passages except passage 4. One reason for this was his low score of 1/7 for questions requiring inferencing in the RO conditions of passages 1-3.

In addition, in the RO condition in passages 1-3 he was unable to answer questions requiring responses regarding key factual elements of the passage. For example, 'What was inside the box?' - 'a black rat' (passage 1) and 'Where did the donkey spend most of its time?' - 'in the field' (passage 2).

WS's scores were markedly higher than TA's in both RO and TTS. The difference between conditions was statistically significant (Chi-square = 7.33, df=2, p = 0.026), with RO being associated with a higher number of accurate answers and HO the lowest.

This task also tested the participants' ability to make inferences. The number of questions requiring inferencing was different across the conditions and was as follows: RO: 11/23; TTS: 7/23; HO: 9/23

Table 3.2: Passage Comprehension: scores for questions requiring inferencing - TA and WS

TA

	Condition		
	RO	**TTS**	**HO**
Total	3/11 (27.3%)	4/7 (57.1%)	7/9 (77.8%)

WS

	Condition		
	RO	TTS	HO
Total	8/11 (72.7%)	4/7 (57.1%)	2/9 (22.2%)

It was not possible to carry out statistical tests with the above data. However, TA scored lowest in RO and highest in HO, whereas WS's scores showed the reverse pattern.

Table 3.3: Passage Comprehension: number of 'don't know' responses – TA and WS

TA

Condition	**% of total possible responses**
RO	34.8%
TTS	39.1%
HO	26.1%

WS

Condition	**% of total possible responses**
RO	8.7%
TTS	30.4%
HO	56.5%

The number of 'don't know' responses in each condition was recorded for each participant. TA show no marked difference across conditions, whereas WS gave considerably more 'don't know' responses in HO.

Sentence Completion Task

Table 3.4: Sentence Completion: comprehension scores - **TA**

* Number in brackets denotes session number *(1,2 or 3)*

Condition / **Sentences (& score / 8)**	**RO**	**TTS**	**HO**
1-8	*(1)* 6	*(2)* 8	*(3)* 5
9-16	*(2)* 2	*(3)* 2	*(1)* 1
17-24	*(3)* 3	*(1)* 1	*(2)* 5
Total (/ 24)	**11 (45.8%)**	**11 (45.8%)**	**11 (45.8%)**

TA's total scores for all three conditions were exactly the same. A McNemar test was carried out to investigate whether when comparing each individual sentence, there was a significant difference in results across the conditions. The results, summarised in Table 3.5 below, indicated no significant effects.

Table 3.5: Summary of McNemar statistical test results – **TA**

Conditions in comparison	**McNemar result**
RO + HO	Chi Sq = 0.1, df = 1, p>0.05
HO + TTS	Chi Sq = 0.13, df = 1, p>0.05
RO + TTS	Chi Sq = 0.13, df = 1, p>0.05

Table 3.6: Sentence Completion: comprehension scores - **WS**

* Number in brackets denotes session number *(1,2 or 3)*

Condition / **Sentences (&Score / 8)**	**RO**	**TTS**	**HO**
1-8	*(1)* 8	*(2)* 8	*(3)* 1
9-16	*(2)* 6	*(3)* 5	*(1)* 0
17-24	*(3)* 4	*(1)* 5	*(2)* 0
Total (/24)	**18 (75%)**	**18 (75%)**	**1 (4.2%)**

Table 3.7: Summary of McNemar statistical test results – **WS**

Conditions in comparison	**McNemar result**
RO + HO	Chi Sq = 19.06, df = 1, p<0.01
HO + TTS	Chi Sq = 15.06, df = 1, p<0.05
RO + TTS	Chi Sq = 0.25, df = 1, p>0.05

WS's total score in the RO and the TTS conditions was exactly the same but she only achieved 1 / 24 for HO. The results of the McNemar test, summarised in Table 3.8, indicated statistically significant results between the RO and HO conditions and HO and TTS conditions. The high chi-square values indicate strong effects. This is due to the extremely low score in HO compared to the other two conditions.

Table 3.8: Sentence Completion: scores for each set of sentences in sessions 1, 2 and 3 - **TA**

	Session 1	**Session 2**	**Session 3**
Sentences 1-8 (/ 8)	6	8	5
Sentences 9-16 (/ 8)	1	2	2
Sentences 17-24 (/ 8)	1	5	3

Table 3.9: Sentence Completion: scores for each set of sentences in sessions 1, 2 and 3 - **WS**

	Session 1	**Session 2**	**Session 3**
Sentences 1-8 (/ 8)	8	8	1
Sentences 9-16 (/ 8)	0	6	5
Sentences 17-24 (/ 8)	5	0	4

With reference to the above tables, there does not appear to be an obvious pattern revealing an improvement in performance with increased familiarity of the task material for either of the participants. Both participants perform best in session 2.

Table 3.10: Sentence Completion: number of 'don't know' responses- TA and WS

TA

Condition	% of total possible responses
RO	0%
TTS	0%
HO	27.3%

WS

Condition	% of total possible responses
RO	0%
TTS	4.2%
HO	95.8%

The HO condition was the only condition in which TA gave 'don't know' responses. 23 / 24 of WS's responses in the HO condition were 'don't know' responses, compared to only one in TTS and none in RO.

Map Marking Task

Table 3.11: Map Marking: comprehension scores – TA and WS

TA

Condition	Score (/11)
RO	0 (0%)
TTS	2 (18.2%)
HO	1 (9.1%)

WS

Condition	Score (/11)
RO	1 (9.1%)
TTS	7 (63.6%)
HO	3 (27.3%)

The low values obtained in this task excluded the use of a statistical test. TA's scores were overall very low, with not much difference across conditions. He was unable to answer any of the questions correctly in the RO condition. WS's highest score was obtained in TTS, which was markedly higher than her lowest score in RO.

Table 3.12: Map Marking: number of 'don't know' responses – TA and WS

TA

Condition	% of total possible responses
RO	90.9%
TTS	54.5%
HO	9.1%

WS

Condition	% of total possible responses
RO	0%
TTS	0%
HO	0%

TA's highest number of 'don't know' responses was in the RO condition. In HO only one response was a 'don't know'. None of WS's responses in this task were 'don't know' responses. However, following the majority of her responses, in particular in the RO and HO conditions, WS stated her answer was 'a guess'.

Passport Task

Following the initial presentation in the TTS condition, TA used the software to listen to certain parts of the text again. WS chose not to do this.

Table 3.13: Passport Task: comprehension scores – TA and WS

TA

	Condition	
	RO	**TTS**
Score (/13)	8.5 (65.4%)	10 (76.9%)

WS

	Condition	
	RO	TTS
Score (/13)	13 (100%)	13 (100%)

There was no significant difference between TA's scores in the two conditions (Chi-square= 0.843, df = 1, p=0.36). WS achieved 100% in both conditions.

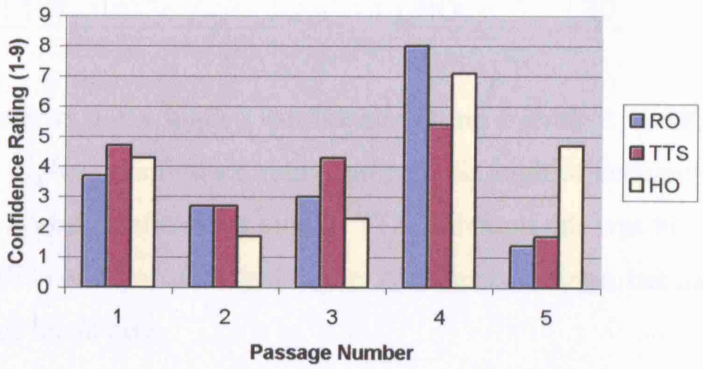
3.2: CONFIDENCE RATINGS

For all tasks in this investigation, participants were not required to give a confidence rating for questions to which they gave a 'don't know' response. It was therefore not possible to carry out statistical tests comparing confidence ratings.

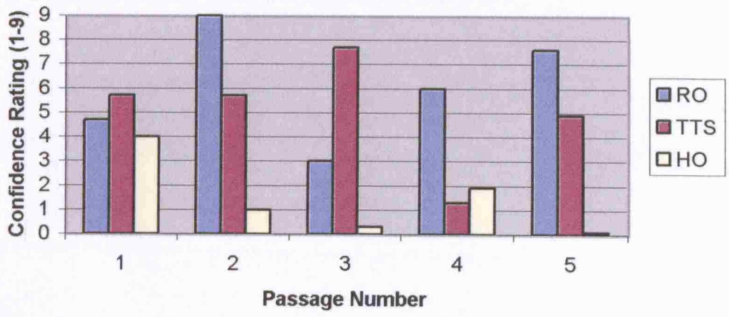
Passage Comprehension Task

Figure 3.1: Passage Comprehension: average confidence ratings for each passage

TA



WS



Average confidence ratings for each passage in all three conditions were calculated by taking the mean of the confidence ratings from all the questions in each passage. Figure 3.1 shows there is no obvious pattern in either participants' results across the five passages. However, WS's ratings are consistently low in HO.

Table 3.14: Passage Comprehension: total confidence ratings

TA

Condition	**Total Confidence Rating (/207)**
RO	94
TTS	85
HO	108

WS

Condition	**Total Confidence Rating (/207)**
RO	145
TTS	100
HO	30

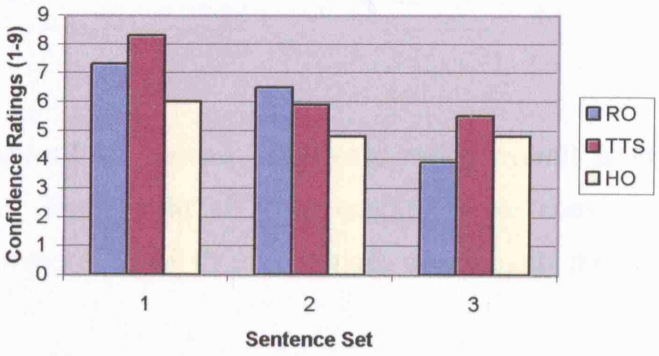
Table 3.14 shows TA's highest confidence rating overall is in HO, followed by RO. TA's highest confidence rating reflects his highest accuracy score in HO. He gave his lowest confidence rating to TTS, although this was his second highest score. The RO condition achieved higher confidence ratings, but his score for this condition was the lowest.

WS's highest confidence rating was in RO, followed by TTS. This reflects her scores. Her rating for HO was considerably lower.

Sentence Completion Task

Figure 3.2: Sentence Completion: average confidence ratings for each set of sentences (sentence set 1 = sentences 1-8; set 2 = sentences 9-16; set 3 = sentences 17-24)

TA



WS

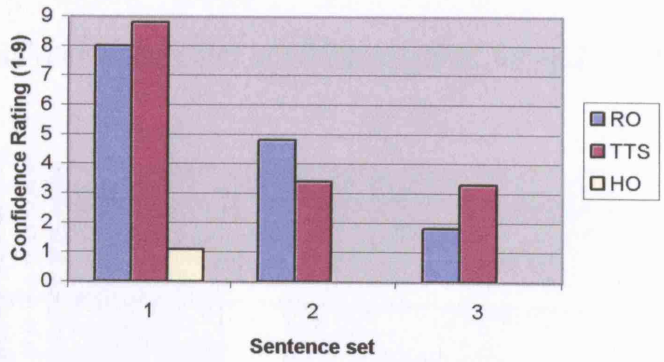


Table 3.15: Sentence Completion: total confidence ratings

TA

Condition	Total Confidence Rating (/ 216)
RO	141
TTS	157
HO	124

WS

Condition	Total Confidence Rating (/ 216)
RO	116
TTS	123
HO	9

Table 3.15 shows TA's highest confidence rating overall is in TTS, with his lowest in HO. Ratings for all three conditions are considerably over 50%. Comprehension scores for all three conditions were exactly the same.

WS's highest confidence rating was also in TTS, followed closely by RO. There was a markedly lower confidence rating in HO, reflecting her very low score.

Map Marking Task

Figure 3.3: Map Marking: average confidence ratings for each condition- TA and WS

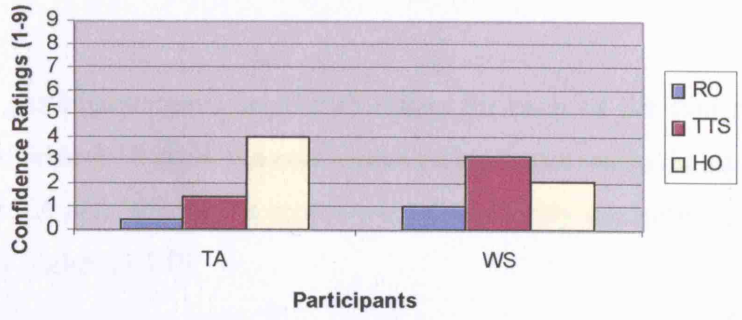


Table 3.16: Map Marking: total confidence ratings

TA

Condition	Total Confidence Rating (/297)
RO	4
TTS	15
HO	44

WS

Condition	Total Confidence Rating (/297)
RO	12
TTS	35
HO	23

TA's confidence rating was highest in HO and lowest in RO. As seen above, his accuracy scores for all three conditions were very low. The higher confidence rating for HO is not reflected by a higher score.

WS's highest confidence rating was in TTS and her lowest in RO, reflecting her scores for this task.

Passport Task

Table 3.17: Passport Task: confidence ratings

TA

Condition	Confidence Rating
RO	7
TTS	7

WS

Condition	Confidence Rating
RO	7
TTS	7

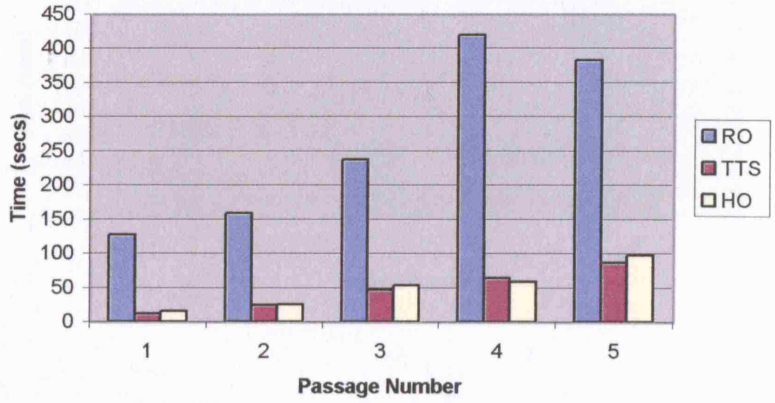
For this task participants gave an overall rating for each of the two conditions. The results in Table 3.17 show the confidence rating was exactly the same in both conditions for TA and WS. WS's scores were also exactly the same, whereas TA scored slightly higher in TTS.

3.3: TIME

Passage Comprehension Task

Figure 3.4: Passage Comprehension: Time (secs) of exposure to text / speech for each passage

TA



WS

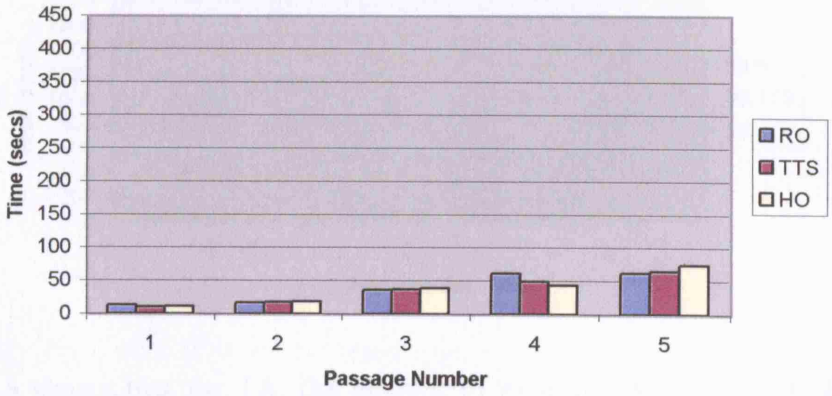
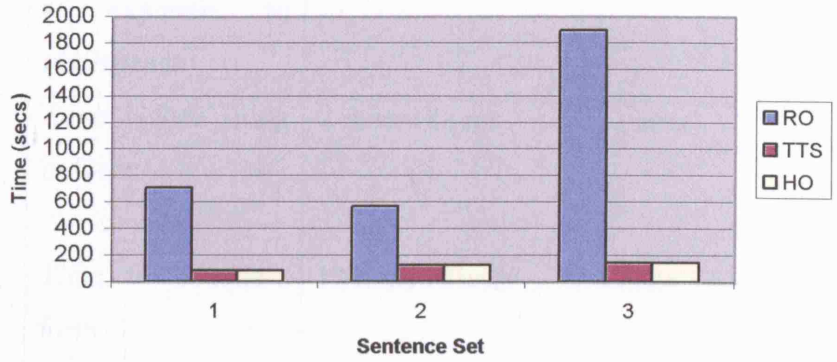


Figure 3.4 shows that for TA, the amount of exposure to the text (secs) in the RO condition was considerably greater than in TTS and HO. The difference was between four and ten times greater, depending on the passage. In the case of WS, there was very little difference in each condition for the first three passages. As the passages became longer and more complex, WS needed more time. The slight difference in time between HO and TTS for each passage can be accounted for by the minimal difference between passage length across conditions.

Sentence Completion Task

Figure 3.5: Sentence Completion: time (secs) of exposure to text / speech for each set of sentences

TA



WS

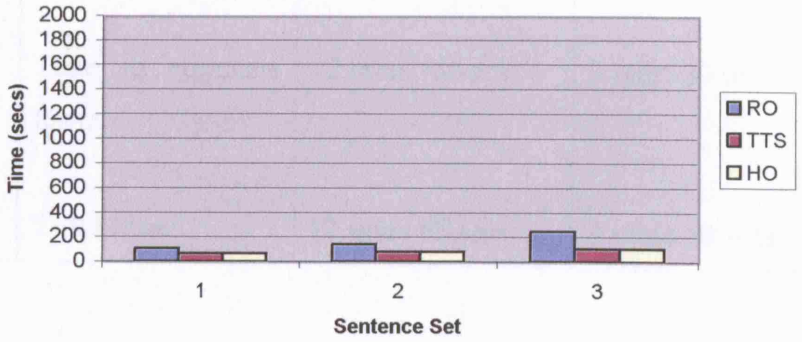


Figure 3.5 shows that for TA, the amount of exposure to the text in the RO condition was greater than in TTS and HO. In particular for sentence set 3, TA's reading time in RO was 31 minutes 35 seconds, whereas in TTS and HO the text was available for 2 minutes 26 seconds. His total reading time in RO for all three sets of sentences was 52 minutes 54 seconds, compared to 5 minutes 56 seconds for TTS and HO. The difference between conditions for WS was much less. Her reading time in RO for sentence set 3 was 4 minutes 8 seconds, compared to 1 minute 47 seconds in TTS and HO. Her total reading time in RO for all three sets of sentences was 8 minutes 16 seconds; it was 4 minutes 12 seconds in HO and TTS.

Passport Task

Table 3.18: Passport Task: time of exposure to text / speech for each passage

Condition	**Time (secs/mins) of exposure to text/speech**	**TA**	**WS**
RO	Time before filing in form:	2 mins 18 secs	33 secs
	Time to complete form:	12 mins 12 secs	4 mins 3 secs
	Total time:	**14 mins 30 secs**	**4 mins 36 secs**
TTS	Presentation time:	39 secs	30 secs
	Time to complete form:	12 mins 16 secs	3 mins 20 secs
	Total time:	**12 mins 55 secs**	**3 mins 50 secs**

In the TTS condition, TA used ReadPlease to listen back to parts of the text on four occasions. The above table shows that TA took a total of 1 minute 35 seconds longer to complete the task in the RO condition than he did in TTS. WS did not listen back with TTS. She took considerably less time, spending 46 seconds longer in RO than in TTS.

Map Marking Task

Table 3.19: Map Marking: time of exposure to text / speech for each passage

Condition	**Time (secs/mins) of exposure to text/speech**	**TA**	**WS**
RO	Reading time:	6 mins 42 secs	1 min 39 secs
TTS	Presentation time:	1 min 16 secs	57 secs
HO	Presentation time:	1 min 24 secs	1 min 3 secs

TA had over five times as much exposure to the text in the RO condition than in the other two conditions. WS spent only slightly longer reading the text in RO.

3.4 QUESTIONNAIRE AND INTERVIEW RESULTS

In the questionnaire about the importance of certain types of reading tasks and the current level of difficulty encountered, TA reported that for 50% of the tasks listed he experienced 'some' difficulty. For the remaining 50% he reported 'a lot' of difficulty, including reading telephone messages, books and magazines, letters, emails and dates on a calendar. He considered 55.9% of the tasks to be 'very important' and 44.1% to be of 'some importance'.

WS reported 'no difficulty' with just over half of the tasks (55.9%), including reading a TV guide, reading emails, letters, dates on a calendar and food labels. This compared with 'some difficulty' for 20.6% and 'a lot' of difficulty for 23.5% of the tasks. She considered 67.6% of the tasks as 'very important', 2.9% of 'some importance' and 29.4% of 'no importance'.

TA was positive about his experience of ReadPlease, using it for between two and three hours each day, mainly at home but also at the training centre and the community clinic. He used a different version to the one used in this study, which he stated had much improved voice quality and more 'natural' sounding voices. He used it for a variety of tasks, including reading emails, news and other material from the internet, finding it most useful for reading letters. He preferred to use it in combination with other types of software, which allowed him to gain maximum benefit from the system. For example, he scanned in letters using a different type of software and he used 'Natural Reader' software to read material directly from the internet, without having to copy and paste into ReadPlease.

TA 'agreed strongly' with all the statements regarding the benefits of ReadPlease, apart from two. He claimed that he understands written material better, he is able to read more quickly and for longer and that it increases his enjoyment of reading. He also reported that he feels more confident about his reading, that it increases his independence and that it would help him in the workplace.

In his opinion, the main limitation of ReadPlease is that it is unable to display more complex text such as diagrams or graphs and that he has to copy and paste

information into the text box. Another limitation he cited was the poor quality of the voices in the version used in this study.

WS did not use computers before her stroke. She was introduced briefly to ReadPlease at the clinic six months ago. She found it of no help for her reading skills and had not used the software since. WS 'disagreed strongly' with all of the statements about ReadPlease; she felt she derived no benefit at all from it, both in terms of improved reading skills and enjoyment and confidence.

She reported that the computer speech was 'just noise', lacked intonation and that hearing it at the same time as seeing the written text was 'confusing'. She said she needed to see a person's facial expression to obtain clues about the message they were conveying.

4: DISCUSSION

The discussion begins with a reminder of the main questions this investigation aimed to address:

1) What was the effect of TTS on the participants' reading comprehension, reading rate and levels of confidence?

2) To what extent were the participants using the combined written and auditory input of TTS, as opposed to the auditory information only?

In addition, as a range of materials was used in this study, it was possible to examine how task demands affected performance. The similarities and differences in the performance of the two participants will be discussed in relation to the above questions.

4.1: Effect of TTS on Reading Comprehension

TA's comprehension scores on many of the tasks in this study were poor, regardless of the condition being assessed. For example, he scored under 50% in all three conditions of the Passage Comprehension task. In this, the Map Marking and the Passport tasks, his scores in TTS were higher than in RO, however the differences were not statistically significant.

WS performed better than TA in all tasks in the RO and TTS conditions. This is in line with her better reading abilities on pre-study assessments. The Map Marking was the only task in which WS achieved a higher score in TTS (7/11) than she did in RO (1/11). In the remaining three tasks her scores in the TTS and RO conditions were either exactly the same (Passport and Sentence Completion) or similar (Passage Comprehension). The fact there was no significant difference in her comprehension scores in the RO and TTS conditions in any of the tasks indicates she did not gain any additional benefit from using TTS.

One reason for her markedly higher score in the TTS condition in the Map Marking task could be due to the benefits of the combined written and auditory modality. When taken in the context of her other results in this investigation, this seems unlikely. She may simply have been able to relate better to this particular text and form a better 'mental picture' of events.

TTS did not significantly benefit either participants' reading comprehension. This finding does not support the research showing significant improvement of comprehension in readers using TTS when compared to reading unaided (Montali & Lewandowski, 1996; Elkind et al, 1993). Instead, it reflects previous findings showing no significant effects of TTS (Elkind et al, 1996; Higgins & Zvi, 1995; Hecker et al, 2002).

These results were surprising as TA reported TTS was a useful tool that helped him read material presented on the computer. Possibly the manner of presentation in this investigation, which differed from the way he operated the system independently, prevented him from gaining maximum benefit. At home, he uses TTS to break down the text into smaller chunks, listening to certain sections or words repeatedly. The Passport task was the only one in which he was able to do this, which I shall discuss in more detail below. Also, TA reported that the quality of speech in the version of ReadPlease he used at home was better than that of the version used in this study; this may have affected his results.

WS's results were consistent with her initial impressions that TTS was unhelpful. In the interview, she said TTS was 'just noise' and she was unable to follow the computer speech, which interfered with her reading. Despite the above findings, it appears she did not find the dual modality distracting. Unlike some of the participants in Elkind et al's study (1993), TTS did not result in significantly lower comprehension scores.

4.2: TTS compared with HO

The HO condition was included to investigate whether any beneficial effects of TTS may be due to participants relying largely on the auditory input as opposed to the combined written and auditory information. Any difference in scores between TTS and HO conditions could shed light on this issue.

The fact TA's total scores for TTS and HO were either the same or similar across all tasks may indicate that TA relied heavily on the auditory input when using TTS. In addition, in two out of the three tasks which included an HO condition, his highest confidence ratings were in HO (Passage Comprehension and Map Marking). It was not possible to analyse confidence ratings statistically.

WS struggled in the HO condition. Her markedly worse performance was most noticeable in the Passage Comprehension and Sentence Completion tasks, which were statistically significant. In the latter task, she scored only 1/24 in HO, compared to 18/24 in both RO and TTS. She was also unable to attempt an answer for over 95% of her responses in HO.

These results could indicate that, in contrast to TA, when using TTS, WS was filtering out or ignoring the auditory information and concentrating on the written form. If she were gaining significant assistance from the auditory information, one would not expect her scores in HO to be significantly lower than RO. Also, there was little evidence WS made use of auditory information when using TTS; in the Passport Task she did not use TTS to listen back over any parts of the text. This could also be the case when she watches television; she largely ignores the auditory information and concentrates on visual cues from the pictures and subtitles to aid understanding. There may be several reasons for this. WS reported in interview and commented on occasions throughout testing that the computer speech was 'just noise'; it was not 'natural' sounding speech and lacked intonation. Participants in studies by Elkind et al. (1993) and Elkind et al. (1996) gave similar reasons for their dislike of TTS.

Despite the above, we know WS was able to understand some information in HO. It is not as straightforward as computer speech being 'just noise', otherwise there would be no evidence of her having comprehended any of the spoken text.

4.3: Effect of TTS on reading rate

Although TA's comprehension did not improve with TTS, the rate at which he could achieve at least the same level of comprehension as in RO was significantly faster. In all tasks, apart from the Passport task, the time to which the participants were 'exposed' to text and / or speech in both HO and TTS was controlled by the experimenter and ended after one presentation of the computer 'speech'. In RO, they controlled how long they read.

In the Passage Comprehension, the Sentence Completion and the Map Marking tasks, TA's total reading time was considerably greater than the total time he was 'exposed' to text / speech in both HO and TTS. In the Sentence Completion task, his total time in RO was 52 minutes 54 seconds, whereas in both HO and TTS it was 5 minutes 56 seconds. The longer and more complex the material, the more marked the difference in reading time between RO and TTS. In the Passage Comprehension task he took on average over five and a half times longer in RO; for passage 1 the RO condition took over six and a half times longer.

Although a direct measurement of reading rate was not taken, as in some of the previous research showing significant improvements in reading rate with TTS (Elkind, 1998; Hecker et al, 2002), TA's results showed a significant difference in time taken in each condition. Despite taking over nine times longer to read the material in RO of the Sentence completion task, his comprehension score was the same as for the other two conditions. In the Passage Comprehension and Map Marking tasks there was no significant difference.

It was expected TTS would lead to a reduction in the time TA spent reading, given his pre-study comments that TTS enabled him to read faster, made reading less tiring and so enabled him to read for longer. This reflected similar

comments made by participants in previous studies (Elkind et al, 1993; Elkind,1996; Elkind et al, 1998; Hecker et al., 2002). In addition, pre-study assessments showed he experienced significant difficulties decoding individual words, contributing greatly to his slow reading speed. TTS would remove the need for so much decoding.

The functional impact of TA's slow reading must be considered. His current reading is inefficient. Given his plans to return to paid work, the speed of his reading will be an important factor in his ability to manage in the workplace. The results showed that using TTS, TA was able to reduce considerably time spent reading, without affecting his comprehension. They also suggest that if TA were given slightly more time in TTS, there may be an improvement in his comprehension. The results of the Passport task, discussed further below, suggested this could be so.

WS was a faster reader than TA. Her total reading time in the RO condition of the Passage Comprehension task was 3 minutes 9 seconds, compared to TA's time of 22 minutes 4 seconds. In the Passage Comprehension task, the difference in reading time in RO compared to TTS was only slight. In the Sentence Completion task, she was almost twice as fast in TTS as in RO, despite achieving the same score. As the sentences became longer and more complex, the differences between the two conditions increased. The results of the Map Marking task, although not typical of WS's results in other tasks, add tentative support to the above results. WS's score in TTS was 54.5% higher than in RO, but the time spent in TTS was 42 seconds less. Despite WS's reports that TTS was of no benefit, there is some evidence to suggest TTS benefited her by reducing the time spent reading, particularly with longer and more complex material.

4.4: Effect of TTS on Confidence

The Sentence Completion task was the only one in which TA's highest confidence rating was in TTS. Whilst it was not possible to do statistical tests on these

ratings, TA's ratings for TTS were lower than those for RO for only one of the four tasks (Passage Comprehension).

There was no conclusive evidence to suggest TA felt more confident in TTS. This does not support research concluding the use of TTS increases feelings of confidence (Elkind et al, 1993; Elkind et al, 1996). TA's results contradict his reports of feeling much more confident when using TTS at home. As with his reading comprehension, it is possible the presentation of TTS in this investigation affected these results.

Contrary to what might have been expected, given WS's reports that TTS gave her no feelings of increased confidence, TTS achieved the highest confidence rating in both the Sentence Completion and Map Marking tasks. In the Passport task her confidence ratings were the same for TTS and RO. In contrast to other tasks, however, in the Passport task WS was able to control the amount of time spent reading in the TTS condition.

4.5: Effect of differing task demands

An interesting finding was the effect of task demands on performance; the exact requirements of the task, as well as the nature of the responses required.

TA's reading comprehension scores varied depending on the nature of the task. He performed best in tasks with a low memory load and those which required him to extract specific information.

TA's best comprehension score was in the Passport task. The same was true for WS, who scored 100% in both conditions. The passages were not as long as the longest passages of the Passage Comprehension task and those of the Map Marking task and did therefore not present the same demand on memory load. It may have also been easier as it was more relevant to the participants. The written responses to this task required manipulating information given in the text. This may have reduced any word-finding difficulties which may have had a bigger impact in the Passage Comprehension.

Interestingly, this task reflected most closely how TA uses TTS at home. These results may therefore be more indicative of any benefits he gains from TTS outside the constraints of experimental conditions. His score in TTS was 11.5% higher than in RO, but the total time taken to complete this task with TTS was 2 minutes 14 seconds less. Whilst there is no statistical evidence, this could mean that when able to use TTS in the most beneficial way for him, TA's reading time is reduced and his comprehension improves. His performance also suggests the memory demands of some of the other tasks hampered his ability to achieve higher comprehension scores.

WS scored 100% in both HO and TTS conditions in the Passport task. In contrast to other tasks, she was able to spend additional time reading in TTS. She had said during testing she wanted to do the same during other tasks, to avoid interference from the computer speech. Given her other scores in TTS, it seems likely her score of 100% in this task may have been as a result of spending additional time reading.

Both participants scored lowest overall in the Map Marking. TA's scores were very low in all conditions. 51.5% of his responses were 'don't know', including 90.9% in RO. Such a high number of 'don't know' responses would seem to indicate he found this task difficult. The Map Marking task registered WS's lowest score in RO, as well as being the only task in which her score in RO was lower than that in HO. WS said she found the texts too long and it was difficult to remember the level of detail required.

The nature of this task was different from the others. There was only one passage in each condition and the passages were longer than those of the Passage Comprehension task, meaning an increased memory load. They also contained larger amounts of information presented in more complex sentences. The maps contained key features, but no detail. Questions were not asked in an order that followed the chronological sequence of the passage, so the participants could not rely on the story sequence to provide clues. The passages did not have characters appearing in the most likely places, for example in the story with Dennis and his

bicycle, the Vicar came out of the school and not the church. Also, the way the participants were required to give their answers in this task was different; by marking points on a map, instead of giving an verbal answer. Although this task was introduced to remove the interference from naming difficulties, it may have proved more difficult, as the participants were less familiar with this form of response.

In the Sentence Completion task the answers took a multiple-choice format; the participants did not have to generate answers. This may be part of the reason for TA's reduced number of 'don't know' responses (4.2%), compared to 33.3% of his responses in the Passage Comprehension task. Both participants' responses indicate there is little gained from repeated exposure to the same stimuli; their scores did not improve following each session. This suggests both participants have difficulties with retaining information, a concern they have expressed in conversation. This supports the idea that the memory load of some of the tasks may have affected their scores significantly.

TA's low scores in the Passage Comprehension could also be due to demands on memory. The harder passages contained more complex sentence structures and vocabulary and some questions did not follow the chronological sequence of the passage. It is possible his low scores reflected a difficulty with word retrieval rather than lack of knowledge. A spoken response was required; he did not have the benefit of multiple choice answers.

To conclude, the nature of the task affected the participants' results considerably. WS appeared to have no difficulties at all in either TTS or RO when considering the Passport task alone. When one considers the results of other tasks, a different picture appears. These findings have implications for future studies, in that task requirements and the type of responses required should be given careful consideration, taking into account the nature of the participants' difficulties.

4.6: Recommendations for future research

As well as issues regarding the presentation of TTS mentioned above, future studies should consider how to represent answers for which participants gave no response in terms of confidence ratings, so that statistical measures can be taken.

They should also ensure equality of demands made across different conditions within a task. The way the Sentence Completion task was administered involved an additional memory load in HO and TTS. The five words from which the participants had to choose an answer were available on the screen throughout RO, whereas in the other two conditions they turned away from the screen after the computer speech ended. In addition to remembering each sentence, the participants had to remember the five multiple choice answers. This did not appear to affect WS's performance in TTS. The fact WS found the auditory modality alone very difficult, however, may have been compounded by the additional memory load. Although TA was not prevented from scoring in these two conditions, the task was made potentially harder. In future, participants should be presented with the five word choices in writing for the TTS and HO conditions, before having to give their answers.

In order to provide a more realistic picture of the effects of TTS on reading comprehension, future investigations should include a greater number of tasks which reflect more closely how the participants use the software at home.

4.7: Conclusion

We know from the results of previous studies and from this one that TTS helps some people with acquired reading difficulties to read more quickly and as a result they are likely to read more material. This is likely to lead to them being better informed and more able to cope with the demands of daily life and of the workplace.

The results regarding reading rate showed TA was able to spend significantly less time reading in TTS without this having a detrimental effect on understanding. There was some suggestion WS may also have benefited from TTS in terms of reducing the time spent reading. There was no conclusive evidence TTS increased the participants' confidence, in comparison to reading unaided. It was possible WS did not feel quite as lacking in confidence as her reports suggested. TA's confidence ratings did not reflect his reports of greatly increased confidence.

TTS did not appear to benefit either of the participant's reading comprehension. Although WS's results were consistent with her reports that she found no benefit from TTS, it did not interfere with her comprehension. TA's results were surprising given his positive reports of experience using TTS. As mentioned above, his results may have been affected by the different presentation of TTS in this investigation compared to how he uses it at home. One could therefore argue the constraints of this particular experimental design did not allow a proper investigation of the effects of TTS on TA's reading comprehension.

It was not possible to draw any definite conclusions regarding the way the participants used the bi-modal information of TTS, however TA's results suggested he may be relying heavily on the auditory input. WS, on the other hand, appeared to be filtering out the auditory information, relying largely on the written text.

Consideration needs to be given regarding further training for the participants in the use of TTS; both had received limited training. A more flexible approach should be adopted, to find out what they could do with the software; it may be TA would also benefit from work on strategies to improve his reading skills in conjunction with his work using TTS, such as highlighting text, main ideas and details. It is also possible WS's experience of TTS may be improved by the use of better quality software, with more natural sounding speech.

In conclusion, more studies are needed to investigate the potential benefits of TTS for people with aphasia. It is clear from the different responses to TTS of both participants that any benefits individuals may gain will vary according to the nature of their reading difficulties.

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APPENDICES

Appendix I:	Passage Comprehension task
Appendix II:	Sentence Completion task
Appendix III:	Map Marking task
Appendix IV:	Passport task
Appendix V:	Confidence Rating scale
Appendix VI:	Questionnaire
Appendix VII:	Interview
Appendix VIII:	Results – Time: Paragraph Comprehension and Sentence Completion; Confidence Ratings: Passage Comprehension

PASSAGE COMPREHENSION

Appendix I

Passage 1
Reading Only

Ted went up to the box.
Then he took off the lid.
He soon put the lid back on.
The box held a big black rat.

Questions

1 What was inside the box?
2 How do you think the rat got in the box?
3 What do you think Ted did next?

Text-to-speech

The ship was in dock.
A girl ran on to the deck.
She hid in a big box and was
still there when the ship left.

Questions

1 Where was the ship?
2 Why do you think the girl was hiding?
3 How do you think the girl felt while she was in the box?

Hearing Only

Kim was late for work.
She took a path by the wood.
She came off her bike on the way.
She fell in the wet mud.

Questions

1 How did Kim get to work?
2 Why to you think she fell off her bike?
3 How do you think she felt after she fell off her bike?

Passage 2
Text-to-speech

The grey donkey was in his field
as usual. Today I had brought
him something. He came and leaned
his head over the fence. I gave
him a carrot from my hand.
He let me pat his neck and back.
Then he turned and trotted away.

Questions

1 Where did the donkey spend most of its time?
2 Why did the donkey put his head over the fence?
3 Had the person in the story seen the donkey before? (If 'Yes') How do you know?

Hearing only

The old palace stands at the top of a steep hill.
It was built long ago. Now it is falling down and no one
Lives there. Only sparrows nest in its crumbling towers. Only rats live in the gloomy cellars. It is a sad, lonely place.

Questions

1 When was the palace built?
2 Why do you think the palace was built on top of a hill?
3 Why is the palace a sad place?

Reading Only

Anna put the picture on her bedroom
wall. She lay on her bed to admire it. It
was full of strange people.
They were dancing and eating.
All at once she sat up and stared.
One of the dancers had turned and winked at her.

Questions

1 What was in the picture?
2 What was unusual about the picture?
3 What do you think happened next in the story?

Passage 3
Hearing Only

Here is a convenient way to prepare rice:

1 Melt a knob of butter in a pan which can be covered tightly.
2 Add two cupfuls of well washed rice and stir vigorously.
3 Add three and a half cups of water and some salt and pepper.
4 Bring the pan to the boil for two minutes and stir thoroughly.
5 Reduce the heat and cover the pan tightly.
6 Simmer for approximately forty minutes.
7 It is important not to raise the lid during this time.

Questions

1 What sort of rice does it tell you to use?
2 What must you do to the rice while it is boiling?
3 What must you **not** do while the rice is cooking?

Reading Only

It was late at night and Alex was on her way home. The roads were silent and empty and all the houses were dark. It was then she heard a tremendous noise above her. Alex looked up into the night sky. She could hardly believe her eyes. Some kind of huge aircraft was hovering above the town. It had flashing lights in many different colours. What she saw next she would remember all her life.

Questions

1 What was the first unusual thing which happened?
2 What was unusual about the aircraft?
3 How can you tell that something strange or exciting happened after Alex saw the aircraft?

Text-to-speech

A card came through the post. It said:
GREAT NEW FROM PETER'S PIZZA PARLOUR!
TWO PIZZAS FOR THE PRICE OF ONE!
Next time you go to Peter's Pizza Parlour for a tasty giant pizza, take this card with you. You will get another giant pizza absolutely free.
Hurry! This offer lasts for just two weeks.

I was pretty miserable. I did not have enough
money for the first giant pizza.
So I would not get another one free.

Questions

1 Where do you think the card came from?
2 What two things do you have to do to get a free pizza?
3 Why do you have to hurry?

Passage 4
Reading Only

The explosion occurred in the early hours of a cold December morning. The entire eighteen-storey block of flats fell down as if it had been made of matchsticks.
The emergency services rushed to the scene. They had to force their way through hundreds of onlookers. Rescue workers searched desperately through the pile of bricks, glass and stone in an effort to extract any victims from the rubble.
Fortunately the building had only recently been completed.
It was not due to be occupied until the next month. An official enquiry was set up and it was discovered that a gas leak had been the cause of the terrible disaster.

Questions

1 Was it a new block of flats, or an old one? Why?
2 What are emergency services?
3 Why was it difficult for the emergency services to reach the building?
4 Can you name three of the things the flats were built with?
5 Why did people search in the rubble?
6 Why was it fortunate that the building had only been recently completed?
7 What caused the explosion?

Text-to-speech

Deflated! That's how everybody felt at Walton Airfield.
Thousands of cubic metres of hopes had collapsed on the team planning an altitude record for the hot air balloon. 'A setback, not a disaster', said co-pilot Glen Roberts after the inflation test failed. He was confident they were not defeated yet. A freak gust of wind had lifted the balloon excessively and the handlers were forced to release it, taking the pilot Linda Francis thirty metres off the ground.
She was hurtled earthwards sustaining minor injuries to her limbs and hands. Meanwhile, the sudden strain proved too much for the delicate silver balloon. It burst, opening a forty metre gash.

Questions

1 Why did everybody feel deflated?
2 Something else was deflated, apart from the people. What was it?
3 What were the people hoping to do with the balloon?
4 Who was the pilot of the balloon?
5 What colour was the balloon?
6 What happened to Linda Francis?
7 How do we know that they would probably try to beat the record again?

Hearing Only

George Frond was director of a sweet factory. For some odd reason he decided to take the engine out of his new car and strip it to its smallest component parts. He knew nothing about engines but he was determined to fulfil this ridiculous ambition.
He obtained all the necessary equipment, including spanners and a small pair of overalls. He undid nuts and bolts, he disconnected wires, dismantled pistons, and even distributed the distributor. Within a few days he was able to admire an enormous pile of metallic pieces on the garage floor next to his car. He never did manage to reassemble it but nevertheless was thoroughly pleased with his accomplishment.

Questions

1 What did Mr Frond decide to do?
2 Where did he do it?
3 Do you think he was a sensible person?
4 Can you name something he took off his engine?
5 What did the engine look like when he had finished?
6 How did Mr Frond feel when he had finished?
7 Do you think he was able to drive his car again? Why?

Passage 5
Text-to-speech

On Sunday evening, October 31st 1938, fascinated listeners to a New York Radio news broadcast heard that a huge meteor had been discovered in New Jersey. A radio journalist at the scene related subsequent events:
'Ladies and gentlemen, this is terrific. The end of the thing is beginning to flake off. The top is beginning to rotate like a screw! The thing must be hollow.'
Increasingly terrified, the incredulous reporter described how a sinister grey monster equipped with grotesque snaking tentacles emerged from the object. In a tremulous voice, he said that a towering humped shape was advancing towards him with tongues of flame shooting from it. Then there was a crash, and the radio went ominously silent. Nationwide chaos and panic ensued. People assumed aliens from Mars had invaded the Earth. In reality, the entire episode had been an exceptionally realistic introduction to a fictitious radio drama.

Questions

1 What did the radio say had been found in New Jersey?
2 What was the first unusual thing the reporter saw happen?
3 What came out of the meteor?
4 Where did people think the grey monster had come from?
5 What was the last thing the reporter described?
6 What did the people listening do after the radio went silent?
7 How do we know that the reporter wasn't telling the truth?

Hearing Only

The audience listened with increasing amusement as the professor outlined his implausible 'Flat Earth' theory. He described how the world was, in fact, flat as a table top and supported by two huge elephants.
'What are the elephants' names?' demanded an irreverent enquirer. 'They have no names,' retorted the speaker adamantly. 'They existed before anything had a name.'
'What are the elephants standing on?' another member of the audience enquired. 'Why they're standing on two gigantic rocks,' alleged the speaker. Someone mischievously asked what these rocks were resting on. 'More rocks' came the confident reply.

Endeavouring to dumbfound the professor another questioner asked what was underneath those rocks. 'More rocks.' The meeting continued for some time like this. Each time the same sarcastic question, each time the inevitable answer. After the twentieth time the professor succumbed to exasperation. 'Listen mate, it's rocks all the way down!' he bellowed.

Questions

1 What shape did the professor think the Earth was?
2 What did he think was just underneath the Earth?
3 Why didn't the elephants have names?
4 How did people try to catch out the professor?
5 How many times did they ask him what was under the rocks?
6 How did the professor feel at the end?
7 How do we know the audience didn't take the professor seriously?

Reading Only

Heavy feet plodded ponderously up the path two doors away.
Mrs Macgregor's terrier yapped its customary protest at any movement it discerned in the road. More plodding up the adjacent path. You could actually hear the letter-box clang open and the laboured breathing of the postman as he pushed the mail through the hole. Soon the suspense would be over. Would that crucial letter from Canada arrive today?

The postman leaned his bike by the wrought-iron gate, peered at the house number, and, yes, resumed plodding towards the door, a thin blue envelope in his hand. It now reposed squarely on the mat. But the address on the envelope announced 'Mrs Macgregor, Number 7...'
The postman had delivered it to Number 5 instead of Number 7. An inescapable and obvious implication followed the anticlimax. Was the letter from Canada now being chewed by the yapping pest?

Questions

1 Who are the three people in this story?
2 Why did the terrier yap?
3 Who does the terrier belong to?
4 Why do you think the person waiting for the postman is listening so carefully?
5 Which house should the blue envelope have gone to?
6 What does the story say might have happened to the letter from Canada?
7 What do you think the person waiting for the letter did next?

SENTENCE COMPLETION Appendix II

1. Ducks swim in a **(bucket, pond, yard, cage, garden)**.

2. Cooking is usually done in the **(bedroom, parlour, fire, kitchen, street)**.

3. One of the water pipes burst, so the occupants of the flat sent for the **(landlord, plumber, charwoman, housewife, bucket).**

4. A burglary should be reported to the **(friends, school, home, office, police).**

5. A salesperson works in a **(hospital, factory, shop, garden, house).**

6. Tom and Joan are happy. In two weeks time, school will stop, and they will go away for their **(home, teacher, holidays, fun, seaside).**

7. The head teacher was held responsible for the discipline and general behaviour of the children in the **(class, school, town, street, family).**

8. In spite of her intensive slimming her weight did not seem to **(slow, increase, slim, decrease, grow).**

9. When she learnt of her failure in the examination despite her hard work, the girl was completely **(disheartened, exhausted, sick, relieved, rejected).**

10. They scanned the 'accommodation' column of the advertisement page, in eager search for a **(flat, cook, motor car, dog, job).**

11. The level of the water was at its highest; after some weeks it began to fall, at first slowly, but afterwards quickly. By the end of the month the river was quite **(high, wet, wide, low, swift).**

12. The art student worked hard and scrupulously at his task. Yet he failed to produce a masterpiece for the obvious reason that he had no **(paints, duty, need, support, talent).**

13. No film is open to public entertainment until it has been **(seen, filmed, distributed, paid for, censored).**

14. Considering the great capacity that a human being has for love, it is astounding that the history of mankind should be frequently blackened by deeds of **(love, manliness, consideration, hate, history)**

15. The old man walked down into the wine cellar and looked for his cherished bottle of **(medicine, lemonade, paraffin, claret, liquid).**

16. After the long hours and strain they had gone through at work, their holiday made them all feel very much **(sun-burned, rested, worse, overworked, energetic).**

17. However brilliant students may be, strong emotional disturbances are bound to affect there.

18. In a totalitarian state, books and all other forms of printed matter are subjected to government **(censorship, dictatorship, publication, printing, subsidies).**

19. No scheme for a change of society can be made to appear immediately palatable, except by falsehood, unless society has become so desperate that it will accept any **(lie, help, falsehood, change, politician).**

20. Few things are more irritating than to be accused of intellectual dishonesty when one is trying hard to fight against **(self-improvement, self deception, cheating, lying, irritation).**

21. To write a successful book requires as much time and energy as to write an unsuccessful one, the difference lying in the fact that the energy in the first case reaps its **(success, books, rewards, writing, energy).**

22. She hardened herself against any emotional entanglements in an effort to spare herself pain, little realising that pain and hurt are an essential part of full **(emotion, living, efforts, enjoyment, hardening).**

23. The boss firmly denied any accusation of discrimination. It was claimed that the policies of the firm were not dictated by **(prejudice, incrimination, accusations, profits, shareholders).**

24. To allow the standards of a new play to be assessed by the box-office is as dangerous to art as to insist on the play's high calibre to the complete neglect of **(prices, criticism, popular appeal, cinemas, art).**

MAP MARKING

Appendix III

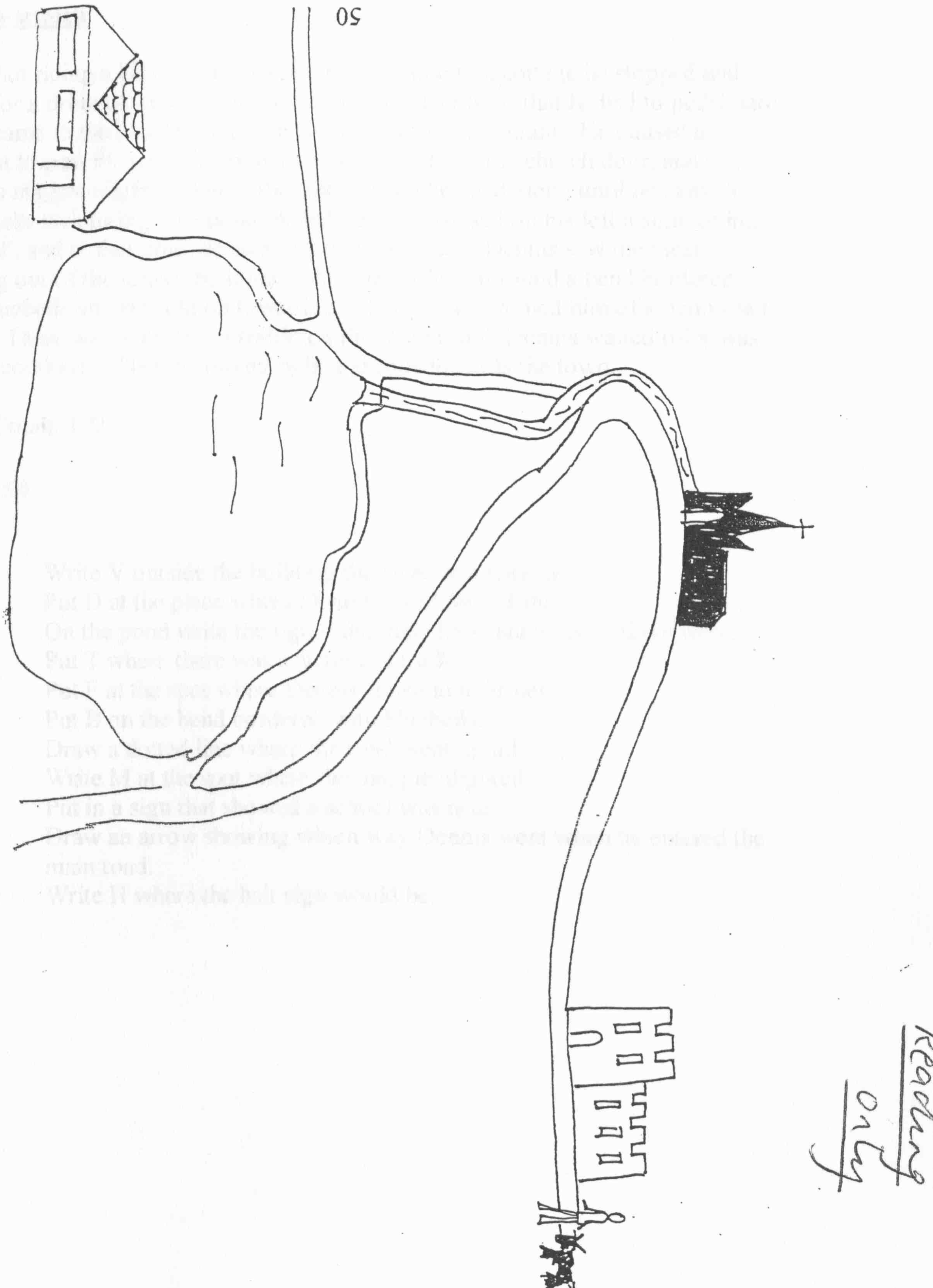
Reading Only

Toby went for a walk with his dog around his estate. A little distance from his castle was an old church, and Toby stopped here to watch a hawk fly past and alight on the turret of his home. He waved at his gardener who was laying traps for a mole and who had dug six holes in the field opposite the church. Round a steep bend Toby came to a bridge crossing a stream. He watched as his dog chased a rabbit into the forest on the other side of the stream. He waited and then when the dog returned he followed a steep path down the hill to a small lake. He saw the vicar walking out of the boathouse holding an oar. He was trying to reach the 'No Poaching' sign that had blown into the water. Toby turned left at the lake and walked towards a gate that faced the main road. He checked that the 'Trespassers will be prosecuted' sign was in place before returning to help the vicar.

Word Count: 174

Questions

1. Write V outside the building the vicar was leaving.
2. Put B where there was a bridge.
3. In the field write the figure that tells how many holes there were.
4. Put F where there is a forest.
5. Put G at the spot where Toby saw the gardener.
6. Draw a dotted line where the path went downhill.
7. Write H at the spot where the hawk alighted.
8. Write P where the 'no poaching' sign was.
9. Draw an arrow showing the way Toby went when he reached the lake.
10. Write G for the gate.
11. Put in the sign that showed this was private property.


50
Reading Only

Text-to-speech

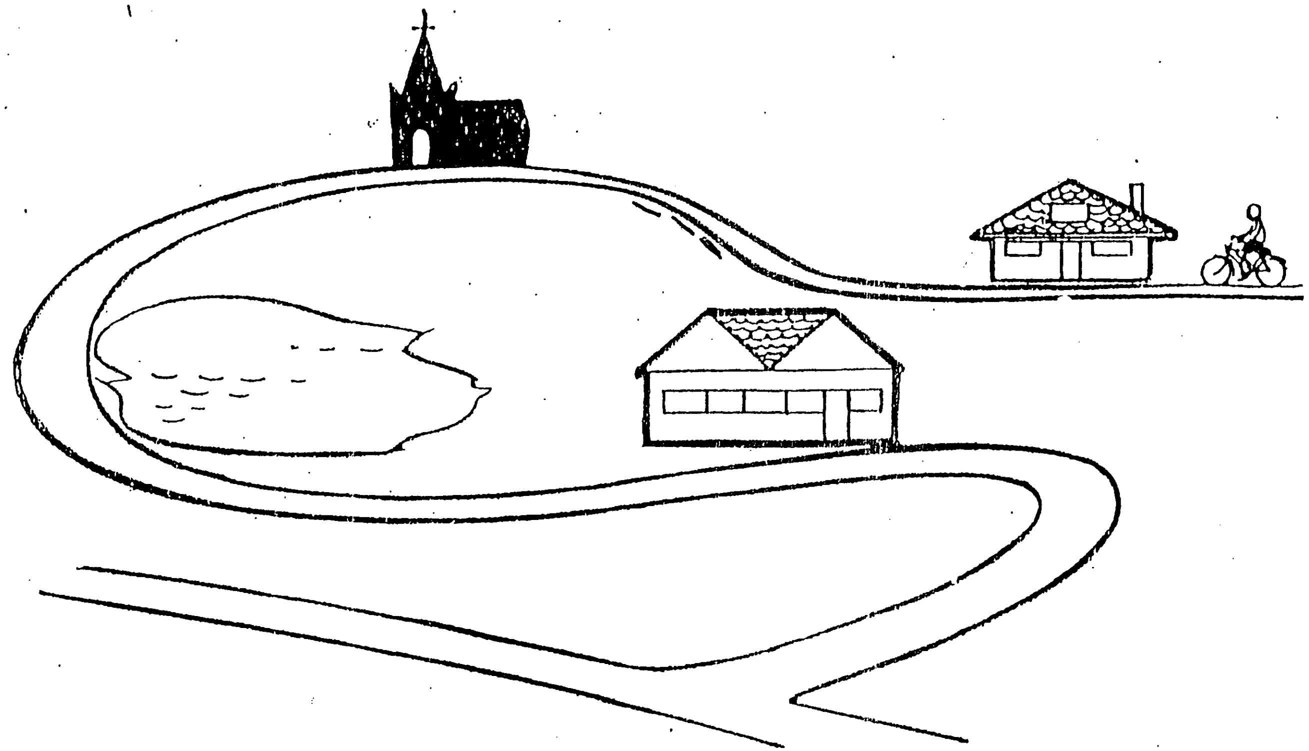
It was hot riding a bicycle, and when Dennis came to a cottage he stopped and asked for a drink of water. The road then rose steeply so that he had to pedal hard till he came to the church, where the way became level again. He paused a moment to pass the time of day with a farmer outside the church door, and to watch a magpie alight on top of the spire. Then he sped along until he came to four ducks swimming on a pond. A little later he passed on his left a sign saying 'School', and at that point he swerved to avoid a cat. Dennis saw the vicar walking out of the school building. Then he cycled on round a bend bordered with bluebells and straight on towards a halt sign that warned him of a main road ahead. There was a stream of traffic on the main road. Dennis waited till it was safe to continue. Then he turned right and rode towards the town.

Word Count: 172

Questions

1. Write V outside the building the vicar was leaving.
2. Put D at the place where Dennis asked for a drink.
3. On the pond write the figure that tells how many ducks there were.
4. Put T where there was a stream of traffic.
5. Put F at the spot where Dennis spoke to a farmer.
6. Put B on the bend bordered with bluebells.
7. Draw a dotted line where the road went uphill.
8. Write M at the spot where the magpie alighted.
9. Put in a sign that showed a school was near.
10. Draw an arrow showing which way Dennis went when he entered the main road.
11. Write H where the halt sign would be.

Text-to-speech.



Hearing Only

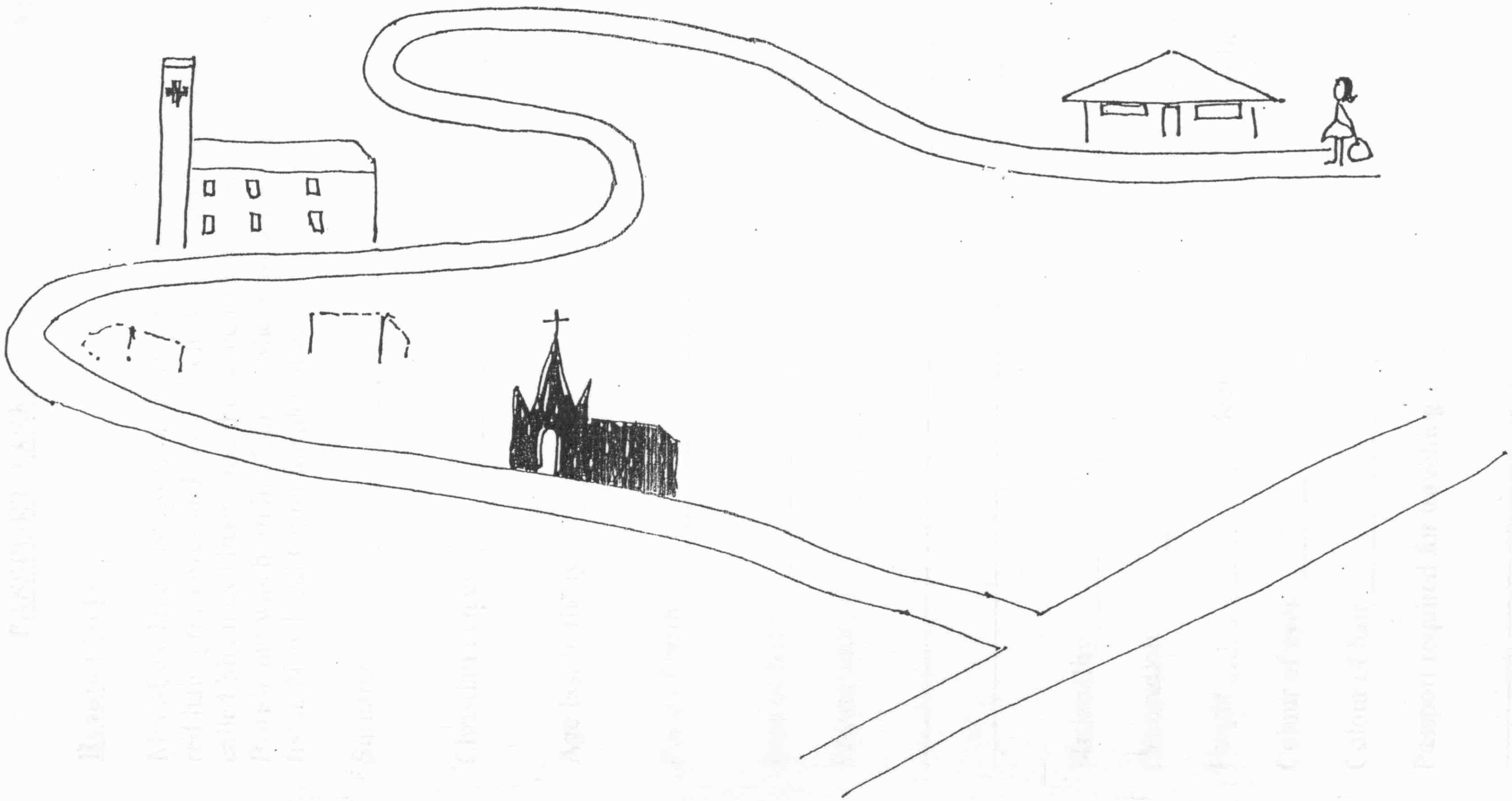
Jane's shopping was very heavy, and when she passed the bungalow she stopped and rested her basket on the wall. Then she walked slowly up the hill and round two bends. A little later she passed on her right a sign saying 'Hospital', and at the point she tripped over a small dog that had slipped its lead. The vicar who was walking out of the hospital stopped and helped. Briefly, Jane sat on a bench opposite the hospital. She checked her shopping, and watched a blackbird alight on the chimney. Then she walked along until she came to five boys playing in a field. Daffodils were growing by the goalposts. Jane decided to walk through the field because the road ahead was closed. A 'men at work' sign warned it could be for some days. Jane saw a fireman rescuing a cat from the top of the church spire. She walked through the cemetery and back on to the road. Just before the main road she crossed at the pedestrian crossing.

Word Count: 172

Questions

1. Write V outside the building the vicar was leaving.
2. Put R at the place where Jane rested.
3. On the football field write the figure that tells how many boys there were.
4. Put P where the pedestrian crossing is.
5. Put F at the point where Jane saw the fireman.
6. Put D where the daffodils were.
7. Write B at the spot where the Blackbird alighted.
8. Put in the sign that showed 'men at work'.
9. Draw an arrow showing which way Jane went when she saw the road was closed.
10. Write H where the hospital sign would be.
11. Put D where Jane tripped over the dog.

Hearing Only



PASSPORT TASK **Appendix IV**

Reading Only

Mrs Mary Jane Lock will be thirty years old on the fifth of next month. She has red hair, green eyes and is two inches over 5 feet tall. She lives in a Surrey village called Shamley Green, and the name of her house is The Old Cottage. She is British and was born in Malaya. She is an actress and is planning to travel to India, Nepal and China for pleasure.

Surname_____

Christian names _____

Age last birthday _____

Place of birth _____

Date of birth _____

Private address _____

_____

_____

Nationality _____

Occupation _____

Height _____ feet _____ inches

Colour of eyes _____

Colour of hair _____

Passport required for travelling to _____

_____

Purpose of travel _____

_____

Text-to-speech

Mr Philip Arthur Dent was forty years old on the first of the month. He has black hair, brown eyes and is one inch less than six feet tall. He lives in an Oxfordshire village called Christmas Common, and the name of his house is Fir Tree Cottage. He is British and was born in Chester. He is an engineer and is planning to travel to Switzerland, Germany and Italy on business.

Surname _____

Christian names _____

Age last birthday _____

Place of birth _____

Date of birth _____

Private address _____

_____

_____

Nationality _____

Occupation _____

Height _____ feet _____ inches

Colour of eyes _____

Colour of hair _____

Passport required for travelling to _____

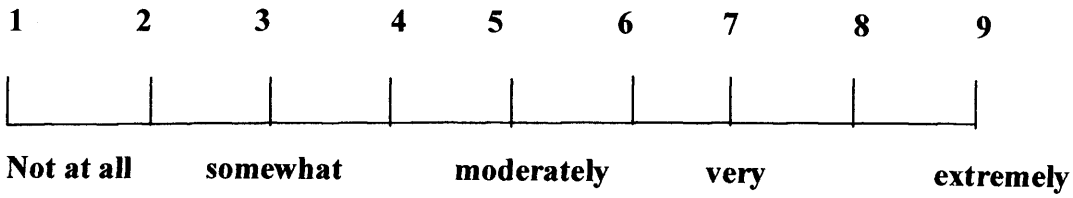
_____

Purpose of travel _____

_____

Appendix V

Confidence Rating Scale



QUESTIONNAIRE Appendix VI

CURRENT READING USE

	Reading Task	**Importance**			**Difficulty**		
		Very	**Some**	**None**	**None**	**Some**	**A lot**
Using the telephone	Reading telephone numbers						
	Reading messages						
Using public transport	Reading signs						
	Reading a timetable						
	Buying a ticket						
	Reading a map						
Leisure activities	Reading books						
	Reading magazines						
	Reading newspaper headings						
	Reading newspaper articles						
	Reading TV guide						
	Reading cinema/theatre guides						
	Reading letters						
	Reading cards						
	Reading emails						
	Reading internet news						
	Reading menus						
	Reading to your children						

	Reading **with** your children						
	DIY-Reading instructions to assemble furniture/use electrical applicances						
	Other						
Shopping	Reading a shopping list						
	Reading clothing labels						
	Accessing products to buy on the internet						
	Other						
Preparing food	Reading food labels						
	Reading recipes						
Medical Matters	Reading an appointment letter						
	Reading a report e.g. speech and language therapy report						
	Reading dates on a calendar						
	Reading the time						
	Reading instructions on medicine						
Financial matters	Reading bank statements						
	Reading financial literature						
	Using a cash machine						
	Using Internet banking						

Appendix VII

INTERVIEW-TA

Using Read Please

1 Do you have a home computer (laptop/pc)?

2 Had you heard of ReadPlease before your stroke?

3 How long have you been using Read Please?

4 Do you use the free version of Read Please or have you bought ReadPlease?

5 What made you decide which version to use?

6 Did you need training to learn how to operate the programme?

7 On average, how often do you use ReadPlease each week? (how many hours approx?)

8 Where do you use Read Please (for example, at home / training centre / work)?

9 How often do you use ReadPlease at the training centre and what for?

10 Do you use Read Please for the following:

- To read emails?
- To read news articles from the internet?
- To read other material from the internet?
- Other uses?

11 What do you find ReadPlease most useful for?

12 How do you think ReadPlease will help you in the workplace?

13 Do you anticipate any problems with using ReadPlease in the workplace?

14 Do you use any other technology to help you with your reading and writing (e.g. Dragon software)?

15 Do you use ReadPlease in combination with Dragon?

16 Is there anything you would like to change about ReadPlease, to make it easier to use?

Do any of the following affect your use of Read Please?

1. Size of font
2. Type of voice
3. The voice quality
4. Having to copy and paste information to read
5. Having to edit text to read

In the following questions the rating scale indicates how strongly you agree with each statement. Please circle the number you feel best represents your opinion.

1	2	3	4	5
Strongly agree	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**

1.	I understand more when I read with ReadPlease.	1 2 345
2.	I can read for longer with ReadPlease.	1 2 3 4 5
3.	I can read more quickly with ReadPlease.	1 2 3 4 5
4.	I enjoy reading more when I read with ReadPlease.	1 2 3 4 5
5.	Using ReadPlease helps me improve my reading skills when I'm reading without ReadPlease.	1 2 3 4 5
6.	ReadPlease would help me in the workplace.	1 2 3 4 5
7.	ReadPlease helps me find out about current events.	1 2 3 4 5
8.	ReadPlease helps me keep in touch with friends.	1 2 3 4 5
9.	ReadPlease helps me find out about topics that interest me.	1 2 3 4 5
10.	ReadPlease makes me feel more confident about my reading.	1 2 3 4 5
11.	ReadPlease helps me be more independent.	1 2 3 4 5
12.	I find ReadPlease very easy to use.	1 2 3 4 5

Reading

1. Was reading important to you before your stroke?
2. Did you used to read books?
3. Has this changed?
4. Did you used to read newspapers and magazines?
5. Has this changed?
6. What strategies do you use to help you with your reading, apart from using Read Please?

INTERVIEW -WS

Using Read Please

1 Do you have a home computer (laptop/pc)?

2 Did you use computers before your stroke? If yes, how often (e.g. every day/ once or twice a week / once a month?)

3 Had you heard of ReadPlease before your stroke?

4 When were you introduced to ReadPlease?

5 Were you given training to learn how to operate the programme?

6 How often did you use ReadPlease in the clinic? (how many sessions?)

7 Have you used ReadPlease at home?

8 Do you use ReadPlease at home now?

9 If not, why do you not use it?

10 Is there anything you would like to change about ReadPlease, to make it easier to use?

11 Do you use any other computer software to help you with your reading and / or writing?

Do any of the following affect your use of ReadPlease?

a. Size of font
b. Type of voice
c. The voice quality
d. Having to copy and paste information to read
e. Having to edit text to read

In the following questions the rating scale indicates how strongly you agree with each statement. Please circle the number you feel best represents your opinion.

1	2	3	4	5
Strongly agree	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**

1.	I understand more when I read with ReadPlease.	1 2 3 4 5
2.	I can read for longer with ReadPlease.	1 2 3 4 5
3.	I can read more quickly with ReadPlease.	1 2 3 4 5
4.	I enjoy reading more when I read with ReadPlease.	1 2 3 4 5
5.	Using ReadPlease helps me improve my reading skills when I'm reading without ReadPlease.	1 2 3 4 5
6.	ReadPlease would help me in the workplace.	1 2 3 4 5
7.	ReadPlease helps me find out about current events.	1 2 3 4 5
8.	ReadPlease helps me keep in touch with friends.	1 2 3 4 5
9.	ReadPlease helps me find out about topics that interest me.	1 2 3 4 5
10.	ReadPlease makes me feel more confident about my reading.	1 2 3 4 5
11.	ReadPlease helps me be more independent.	1 2 3 4 5
12.	I find ReadPlease very easy to use.	1 2 3 4 5

Reading

a. Was reading important to you before the stroke?

b. Did you used to read books?

c. Has this changed?

d. Did you used to read newspapers and magazines?

e. Has this changed?

f. What strategies do you use to help you with your reading?

RESULTS – TIME

Appendix VIII

Passage Comprehension

TA

Passage	RO	TTS	HO
1.	2 mins 07 secs	12 secs	15 secs
2.	2 mins 39 secs	24 secs	25 secs
3	3 mins 57 secs	47 secs	53 secs
4.	6 mins 59 secs	1 mins 4 secs	59 secs
5.	6 mins 22 secs	1 min 27 secs	1 min 37 sec
Totals	**22 mins 4 secs**	**3 mins 54 secs**	**4 mins 9 secs**

WS

Passage	RO	TTS	HO
1.	13 secs	10 secs	11 secs
2.	17 secs	18 secs	19 secs
3	36 secs	37 secs	39 secs
4.	1 min 1 sec	49 secs	44 secs
5.	1 min 2 secs	1 min 5 secs	1 min 14 secs
Totals	**3 mins 9 secs**	**2 mins 59 secs**	**3 mins 7 secs**

Sentence Completion

TA

	RO	TTS	HO
Sentences 1-8	11 mins 48 secs	1 min 25	1 min 25
Sentences 9-16	9 mins 31 secs	2 mins 5 secs	2mins 5 secs
Sentences 17-24	31 mins 35 secs	2 mins 26 sec	2mins 26 sec
Totals	**52 mins 54 secs**	**5 mins 56 secs**	**5mins 56secs**

WS

	RO	TTS	HO
Sentences 1-8	1 min 48 secs	1 min 5 secs	1 min 5 secs
Sentences 9-16	2 mins 20 secs	1 min 20 secs	1min 20 secs
Sentences 17-24	4 mins 8 secs	1 min 47 secs	1min 47 secs
Totals	**8 mins16 secs**	**4 mins 12 secs**	**4 mins 12secs**

RESULTS – CONFIDENCE RATINGS

Passage Comprehension
(n.b. d/k = 'don't know' response)

TA

Passage	RO Individual questions	TTS	HO
1.	d/k,6,5	9,d/k,5	3,5,5
2.	5,d/k,3	d/k,5,3	d/k,d/k,5
3.	6,3,d/k	7,3,3	d/k,4,3
4.	5,9,7,9,9,8,9	7,9,7,d/k,d/k,7,8	9,9,9,7,8,d/k,8
5.	5,d/k,5,d/k.d/k,d/k,d/k	5,d/k,d/k,7,d/k,d/k,d/k	8,5,d/k,7,6,d/k,7

WS

Passage	RO Individual questions	TTS	HO
1.	9,5,d/k	9,3,5	9,d/k,3
2.	9,9,9	7,5,5	3,d/k,d/k
3.	3,3,3	9,5,9	d/k,1,d/k
4.	5,9,9,d/k, 5,5,9	d/k,9,d/k,d/k,d/k,d/k,d/k	3,d/k,d/k,3,3,3,1
5.	9,9,9,9,1,9,7	5,d/k,5,7,3,9,5	d/k,1,d/k,d/k,d/k,d/k,d/k